THE

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J. A. BERLY'S

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For 1893

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THE HISTORY OF THE TRANSMISSION OF INTELLIGENCE.

FOR a short and happy canter over the classic ground of telegraphic history, we commend our readers to the address delivered by Prof. Thomas Gray, C.E., F.R.S.E., before the Congress on the celebration of the second century of the American patent system at Washington City, D.C.

From the beacon fires of Eschylus and Polynius, through the long range of flag and semaphore systems of Schottus, Kessler, James II. of England, Dr. Robert Hook, M. Amontons, Edgeworth, and others, he brings us to the earliest traces of the electric telegraph, and the consequent termination of mechanical signals.

The first notion of a magnetic telegraph dates from 1617, in what Prof. Gray aptly terms, "the fable period of telegraphy." To Stephen Gray he attributes the earliest experiment in this regard, he having in 1729 discovered that the electrical influence could be conveyed to a distance by means of an insulated wire. Then follows the suggestion of Charles Marshall, of Renfrew, Scotland, 1758, for an electrostatic system, a germ which developed into the more complex method of Ronalds, of Hammersmith, who, in 1816, elaborated a pith-ball telegraph, worked in conjunction with a synchronising disc, upon which the letters were printed.

The discoveries of Sulzer, Volta, Galvani, Nicholson, Carlisle, Sömmering, Coxe, and Sharpe led to a rudimentary chemical telegraphic system. Prof. Gray then reminds us that Romagnosi, of Trente, in 1805, was the first to show that a wire conveying an electric current is capable of deflecting a magnetic needle. This fact lay idle until again brought to light in 1819 by Oersted, who thus laid the foundation of electro-magnetic telegraphy.

The needle telegraph of Schilling dates from 1832. It was to some extent developed by Gauss and Weber, who used induced currents, produced by the motion of a coil of wire surrounding a bar magnet, this, again, being the outcome of experiments by Faraday and Henry.

Apart from the discoveries of Ampère, Arago, Sturgeon, Steinheil, Morse, and others, Prof. Gray gives the following claims of Prof. Henry as being well founded and deserving of quotation:

"1. Previous to my investigations, the means of developing magnetism in soft iron were imperfectly understood, and the electro-magnet which then existed was inapplicable to the transmission of power to a distance."

"2. I was the first to prove, by actual experiment, that in order to develop magnetic power at a distance, a galvanic battery of 'intensity' must be employed to project the current through the long conductor, and that a magnet surrounded by many turns of one long wire must be used to receive this current."

"3. I was the first to actually magnetise a piece of soft

iron at a distance, and to call attention to the fact of the applicability of my experiments to the telegraph."

"4. I was the first actually to sound a bell at a distance by means of the electro-magnet."

"5. The principles I had developed were applied by Dr. Gale to render Morse's machine effective at a distance."

In such a review of the subject, it was perhaps impossible to exclude the controversy as to the relative merits of Morse, Henry and Vail. Working, as they did, at the same time and with similar objects, it is scarcely to be wondered at that their labours have lost, here and there, their distinctive characters, and their efforts have merged into a single achievement. That Vail and not Morse invented the code alphabet seems well established in the mind of Prof. Gray. The dictionary of numbered words, proposed by Morse, originated with Edgeworth in 1794 in connection with his semaphore signals. The modification of the recording apparatus from a vertical pendulum and recording pencil to the compact instrument with horizontal lever and metallic stylus, marking by indentation, used on the first telegraphic line between Washington and Baltimore, must also be credited to Vail. Thus it would appear Prof. Gray leaves his countryman, Morse, very little to stand up in. Here and there in English telegraphic history, ancient and modern, and very modern, there is need for a Prof. Gray to sift things out and tell us "who's who" as well as "what's what."

THE MEASUREMENT OF FURNACE TEMPERATURES BY MEANS OF THERMO-COUPLES.

IN every branch of industry to-day there is a clamour for accuracy. "Rule-of-thumbism" is rapidly becoming a thing of the past; the spread of technical education is probably responsible for its death blow. Electrical science has played no inconsiderable part in the evolution of accuracy of method and especially of accuracy of measurement; illustrations of this will occur to all our readers, but a striking instance has recently occurred in metallurgical operations which may be usefully considered.

Only a few years ago metallurgists were wont to judge of the temperature of their furnaces by the colour of the glowing contents; but the eye, however it may be educated, is by no means a reliable scientific instrument: and most thermometric methods were incapable of application. The use of the spectroscope was a great advance, but even this, excellent though it was, left much to be desired, hence the leading metallurgists in this country and in France have for some time been endeavouring to enlist electricity into their service. The results have fully justified the expectations.

The use of thermo-junctions, which has been consistently advocated by Prof. Roberts-Austen for several years, now appears likely to become general, Sir Lowthian Bell having led the way. Hitherto, a systematic method of obtaining autographic results has been wanting; but it is believed that by an ingenious combination of thermo-couples, photography and clock-work, this want is now supplied.

One form of this autographic temperature recorder possesses the following essential feature: there is a camera containing a reflecting galvanometer of the Deprez or D'Arsonval type, and of about 200 ohms resistance. A thermo-junction placed where the temperature is to be measured, is connected with this galvanometer, the amplitude of whose deflection indicates the temperature to which the thermo-junction is exposed. By allowing a spot of light from the mirror of the galvanometer to fall upon a sensitised photographic plate moved by clockwork, an autographic record of the variations of temperature can be obtained.

For practical use it was necessary first to simplify the portion of the apparatus recording the movement of the spot of light; and, second, to avoid the necessity for shifting a single thermo-junction from furnace to furnace by having a separate one in each furnace, provision being made for placing each centre of heat in turn in connection with a single galvanometer and recording instrument.

The first object was attained by substituting for the sensitised plate, a cylinder to move by internal clockwork at the rate of one revolution in twelve hours. This cylinder was covered with sensitised paper, whilst the portion of the camera containing it could be detached from the rest of the apparatus and removed to the dark room for the development of the record.

To attain the second object the apparatus was arranged for placing any one of a number of different centres of heat in connection with the galvanometer, the records being intermittent. The duration of the test in each case is under the immediate control of the operator, who, by merely turning a handle, determines which heat centre shall be placed in connection with the galvanometer and the duration of the test. This shifting can also be accomplished by clockwork, and is then entirely automatic.

An ingenious device for indicating which furnace or heat centre is in connection with the galvanometer is as follows:—For No. 1 furnace the light from a lamp passes through a single slit and gives a single datum line, while for No. 4, say, the light passes through four fine parallel slits, and produces four fine parallel lines, of which the lowest is the true datum line, and the deviation of the line traced by the light from the galvanometer mirror from the datum line when in use, measures the temperature at the thermo-junction at that instant.

The best resistance of galvanometer to employ in this work is 200 ohms. The thermo-junctions are very durable and constant if made of platinum-rhodium; if likely to be exposed to "metallic rain" in the furnace they should be covered with clay, otherwise they are best free.

DYNAMOS IN AMERICA.

IN the *Electrical Engineer* of New York, November 16th, appeared an article on Non-polar Dynamos, which, if it proves anything at all, proves that the first principles of dynamo-electric induction are somewhat obscure to the minds of some American electricians. In the same paper, dated November 30th, we have an article on Ball's Unipolar Dynamo. This machine was described by us in 1884, and illustrated, bringing forth some criticisms on its peculiar construction, Mr. Rankin Kennedy pointing out in a letter

to the Editor that the applying of one pole only to a Gramme armature was not new, as he had worked an A Gramme dynamo with one of the poles removed. To the ordinary electrical engineer on this side, this machine is what "Robert" in *Punch* would call a "Staggerer." The field magnets are composed of four cores in place of two; two cores would be much better magnetically than four; they would cost much less, and would not require so much copper wire to produce the same strength of field. One feels very inquisitive regarding the reasons for using four cores in place of two, but nowhere in the article are any such reasons alluded to.

Such a dynamo works well enough, perhaps quite as well as a dynamo built on strictly scientific lines, just as an omnibus with five wheels would work as well as one with four wheels; we would, however, be curious to know what use there was for the fifth wheel. It is a constant current dynamo, and therefore the use of a large armature in a weak field is permissible. The machine is simply two Gramme dynamos in which the magnetic resistance of the air space (or *entre-fer*) is very much exaggerated. The armatures are very large, hence their reaction on the field is very decided. This reaction tends to maintain constant current under varying external resistances. The high magnetic resistance of the "air space" reduces the output of this dynamo per pound of copper used in its construction, and the high pressure required to work arc lamps in series is obtained by a great number of turns of wire in the armature coils and employing high peripheral speeds.

There is some reason for using two armatures, especially when they are closed coil armatures; for high-pressure work they can be coupled in series; but what reason there is in building a machine with such enormous air space resistance as there must be in this dynamo the article sayeth not.

This dynamo is called a "unipole" dynamo, but in reality it is a four-pole dynamo, if dynamos can be said to have poles at all.

The non-polar dynamo has ever had a fascination for electrical students on this side. Prof. Forbes has carried this class of machine to the highest perfection yet attained, but still it is not a machine of much practical use; the experimental machines shown in illustrations in the *Electrical Engineer* of New York are not novel. A conductor cutting a uniform field at a constant speed at right angles to the lines of force generates a uniform current, hence a disc or cylinder rotated in a field of constant polarity has currents generated in it; but if instead of one conductor we employ two or more in series to enable us to get a high pressure, then we must not only cut the field, but have an increase and decrease of the number of lines of force passing through the circuit, of which the moving conductors form a part. A solid disc or drum armature of metal in a non-polar dynamo represents only half a turn on an ordinary dynamo armature coil; the other half-turn is represented by the external circuit. Immediately we introduce a complete turn, or several complete turns, into a non-polar armature, then the generation of current by increase and decrease of lines of force enclosed comes into play; and there is the rock on which non-polar dynamo schemes are wrecked, they provide for the cutting of the field, but they don't provide either for the enclosing of the lines as they increase and decrease, or for their increase or decrease at all.

Human Dynamics.

THIS, or "the study of motive and character," was the title of the address delivered by Mr. Ll. B. Atkinson, A.M.I.C.E., the newly-elected president of the O.S.A. If we try to differentiate a function of the human organism, motive, character, or what not, as Mr. Atkinson suggests, and plot a curve, there is one feature that comes out very strongly—it is the "eccentricity" of recent mental specimens. The *slope*, too, of many individuals is perfectly alarming; the police, we believe, are studying the calculus with the express purpose of determining the differential coefficient of some gentlemen who have recently become smaller and smaller without limit. There was once a man who tried to study motive. He had learnt mechanics and electro-dynamics at a technical college; he knew all about machine design; he could calculate the M of a fly wheel on his finger tips; and it was his custom, even on Sundays, to estimate J from the heat evolved when he dropped his offering into the plate. It is said of him that he even swore in symbols, but certainly he slept in brackets, and on cold nights wrapped himself up in a problem. One day he was lost. Years afterwards an old college friend found him involved in the dynamics of a rigid particle; he was rocking it in a parabolic curve about a horizontal axis; he had measured his *length* on the floor, and was counting his seconds by the kitchen clock; from these data he was actually trying to deduce the value of g at that spot. Ultimately he and his friend came to the conclusion that it was an impossible case. Since then nobody has seriously studied human dynamics.

Electro-Therapeutic Apparatus.

ELECTRICIANS have often been mystified and appalled by the complicated and apparently irrational arrangements of the devices in which makers of electro-medical apparatus delight. We have ourselves been struck with the evidence such apparatus frequently shows of what certainly looks like a desire on the part of some manufacturers to mystify their customers and render it imperative that none but themselves shall be able to perform the simplest changes in regulation, to say nothing of repairs. It is probable that this unnecessary complication is to a large extent due to the fads and fancies of their customers, who, knowing little or nothing of electricity and its control, order apparatus to be constructed upon principles more imaginary than real. This seems to be the opinion of the members of the American Electro-Therapeutical Association, as evidenced by the paper read at its recent meeting in New York by Dr. W. J. Herdman, entitled "The need for greater Simplicity and Uniformity in Electro-Therapeutic Apparatus." Dr. Herdman, and those who followed him, spoke strongly of the difficulties they had to contend with in this matter, and we feel sure that their opinions receive a hearty echo among the electro-therapeutists of this country. Now that greater attention is being paid by medical men to the physics of electro-therapeutics, no doubt the makers will not be slow to turn out apparatus that shall meet the more enlightened requirements of the present day. There is one point, however, which the makers alone are responsible for, and which has long cried loudly for reform. We mean the construction of apparatus in such a manner that it is almost impossible for the medical purchaser to carry out even the simplest repairs himself. Many of the medical batteries, for instance, easily and frequently get slightly out of order. These, if properly constructed, might be readily and quickly repaired by the purchaser, but this the makers appear to object to, under the impression, we suppose, that it is more to their interest to have the apparatus brought back to them for repairs that they can charge for, than to allow the purchasers to put things right for themselves. We think this is very short sighted policy.

Many purchasers of such apparatus get annoyed at the failure of some comparatively costly battery or instrument, and rather than incur fresh outlay for repairs, give the whole thing up in disgust, and vow that electro-medical apparatus is too costly and troublesome for them. We think that makers of electro-medical, as well as of other apparatus, should aim at simplicity and straightforwardness of construction. This would tend to popularise their apparatus, and so create an increased demand which would more than compensate for the questionable advantages of unnecessary complication.

Over-Capitalised.

THE "Arcas" Plating Company is advertising largely in order to obtain subscriptions to its capital of £80,000, which we hope it will not get. The information published with the prospectus is entirely insufficient to enable any judgment to be formed as to the merits of the process which it is proposed to exploit, whilst the vague generalities and sanguine estimates upon which the expectations of success are based only lead to the supposition that there is less business method about the company than is necessary to produce a commercial success. £10,000 in cash and more than half the share capital is too much to pay for a process of depositing an alloy of silver. It is safe to say that if the process has anything like the merit claimed for it, the amount paid for advertising the prospectus would have gone a long way to establishing it on a sound commercial basis. But with the present rage for company promoting that would never do.

A Silly Leader.

IN the *Daily Telegraph* for the 16th inst. there is a short leader on Prof. Forbes's paper on the utilisation of Niagara. "America," it seems, "is sadly in need of a native Ruskin to pronounce a forcible opinion" on the Niagara scheme. But in the absence of that species of critic, the *D. T.* ventures to express a few opinions. Our daily contemporary tells us that this "is not by any means the first time" the idea of turning Niagara into a "glorified mill-stream has been seriously mooted, and perhaps the danger (*sic*) will pass over as it has done before." Seriously mooted, indeed! Shades of the Civil Engineers! have we not already bored a great tunnel nearly two miles long at the place, besides having dug out several canals and erected massive machinery? Then there is another piece of information peculiarly *D. T.*: "Obviously," now (wherefore is it obvious?), "this power cannot be transmitted to a great distance." We fancy it can. But the inability of the power to go to the factories is, we are told, to lead the factories to go to the power. On the Niagara horizon there is to loom a city which is to threaten New York for very magnitude, and which shall be "a good imitation of the Black Country," with "any number of factory chimneys rising on both sides of the world's wonder." Truly a world's wonder, if engineers run up tall, smoky factory chimneys to drive turbines; or if the utilisation of water power brings the grimy dirt of the coal be-sprinkled Black Country! All this to get a paltry "annual income of two and a half millions of pounds." *Quid non mortalia pectora cogis auri sacra fames?*

Separable or Detachable Incandescent Lamps.

IN the issue of the *Electrical World* for December 3rd, Dr. L. M. Böhm has an article on various ideas that have been suggested for constructing lamps on this principle. The article purports to be a short historical sketch, though it cannot certainly be regarded as a complete *resumé* of all the devices that have been proposed, being built up principally of extracts from American patent specifications and figures of various designs. The author is somewhat diffuse on his own claims for being the inventor of the first lamp containing a ground glass stopper with the conducting wires, supporting the filament, sealed into the said stopper. Dr. Böhm's original application for a patent embodying this principle, dated November 22nd, 1880, was not successful, however, and the first to obtain a patent on these lines appears to be Hiram S. Maxim. It will be remembered by our readers that the Westinghouse Company are introducing this general plan in their new lamps—which, by the way, should now be on the market, having been promised for sale on and after December 1st—and Dr. Böhm is a little sore at seeing his old invention becoming commercially applied, without having apparently reaped any pecuniary benefit. With all due deference to the author of the article, we cannot but regard the plan of using a ground glass stopper, containing leading in wires, as a very obvious device, and we consider that those who first successfully put it into commercial practice deserve decidedly more credit than he who first suggests the bare idea. We have yet to see, however, whether this plan *will* live commercially. Dr. Böhm, in criticising the new Westinghouse lamp, expresses grave doubts, but without giving reasons, as to the permanence of the vacua in incandescent lamps containing anything except platinum wire, and also as to the desirability of employing a soluble sealing compound round the stopper. But he appears to have no doubt whatever as to the suitability of using a ground glass stopper pure and simple.

Turbine Governing.

A WRITER in a recent number of our American contemporary, *The Electrical Engineer*, deals with this most important question. One of the greatest difficulties in applying water motors to electric power generators which are liable to sudden changes in load is the lack of promptness in the governor. This difficulty is also met with in the steam engine, especially the compound and triple expansion engines, and to a greater extent in the gas engine. It is highly important in each case that the engine should respond to the slightest movement of the governor within the least possible time. Every detail set in motion should be well fitted so that there is no "slack" or back-lash to take up when the governor changes. In America it is customary on some mill sites to arrange that the pressure of the water keeps everything tight and well fitted; but this makes it harder to open the gate and has other objectionable features. So much practical difficulty has been found on some of the American power stations that gate-governors have been abandoned and the engines are run at full load all the time. When the demand for power is not up to the full supply from the dynamo which is run by the turbine an iron wire resistance is automatically shunted across the mains, taking off more or less of the power in proportion to the number of wires thus bridged across the circuit. In stations with low load factors by far the greater proportion of the power would thus be wasted, and the space occupied by rheostats to safely carry so much current must be considerable. The amount of heat generated must also cause an uncomfortable rise in temperature at times. In summer time an electric light station would have little else to do than cook the resident engineer and his staff. Besides this method is wasteful of water, for the full flow must be kept up in the engine whatever the load. It would be more economical to pond back this surplus water till it was wanted, or to rent it to some other mill. Where, however, there is abundance of water which cannot be otherwise used this method is perhaps the neatest mode of doing without a governor.

THE USE OF COMPOUND-WOUND GENERATORS FROM A PRACTICAL POINT OF VIEW.*

BY W. M. WILLIS.

I HAVE been asked to read a paper this evening on a subject which would bring up a good warm discussion, and I believe, if I am not much mistaken, I shall, before I am through, have struck the right cord to realise the desired result. The subject I have selected is the compound winding of generators from a practical standpoint, with especial reference to their use in practice.

In the first place we find that in all electric installations, whether for incandescent lighting or power transmission, the first requirement is that the dynamo or dynamos shall maintain a constant potential difference at the brushes, or at some distant point. On examination, we find that the shunt machine, by armature reaction alone as a single factor, not to mention the host of other factors which enter into the equation, is unable, in practice or theory, to fill the beforementioned requirement, viz., to keep a constant potential difference at any point predetermined, without hand regulation or some form of governing device, such as an automatic rheostat, for instance. Therefore, one has to look for some one of the many devices introduced which will the most nearly fill the requirements in practice, as well as in theory; and I believe it has been decided by electricians the world over, that the requirements are the most nearly reached by the compounded machine, the electromotive force of which keeps constant or increases directly as the load on the machine increases.

We find in the building of compounded machines that certain conditions are assumed. In the first place we find that the speed of the machine is assumed constant, whatever that constant may be. This, of course, introduces a slight source of error, as in practice, in a large percentage of cases, more especially small plants, the speed varies at least 2 per cent., as I believe 2 per cent. variation in speed between full and no load is about the best warranty obtainable on the greater number of makes of high-speed engines with which one in modern practice has mostly to deal; and this, be it remembered, does not take into consideration the creepage of dynamo belts, which amounts to from 1½ to 2½ per cent. by actual experiment, not to mention belt slippage. All these factors, of course, increase in direct proportion to the load. In railway practice and in transmission of power a few per cent. variation is, however, permissible.

It would seem advisable to over-compound even railway generators to a slight extent to make up for small variations of speed. This may be accomplished in some machines without special winding, as, for instance, by varying the length of a German silver shunt used to shunt a portion of the main current past the series coils and thus allow a larger proportion of main current to flow through the series coils of the machine. In incandescent lighting, however, variations of speed are attended with far more evil results, and in only too many cases the dynamos are blamed for inconstancy of the candle-power of lamps when it is the transmission of mechanical power to the dynamo shaft that is at fault.

We will now consider the use of the compounded and over-compounded machines under various conditions. We will first take the case of a compound-wound machine running singly, and we find that its series winding may be constructed with such a number of turns that it will practically compensate automatically from no load to full load; for all internal reactions, such a machine is evidently eminently fitted for railway and similar work, as it will maintain a practically constant potential at the generating station.

The next case will be one in which we have an over-compounded generator, running singly, and we find that its series coils if correctly constructed will fairly compensate for internal reactions, and also for the varying percentage of loss in line, all of which vary directly with the current. A machine of this class and under these circumstances would be admirably fitted for incandescent lighting and transmission of power, and more highly fitted for railroad work than a straight compound machine.

The next case we will take up will be one in which we have two compound-wound machines running on the three-wire system. Their series windings will compensate for internal reactions, and thus keep the potential at generating station constant, even if the system becomes unbalanced, as the excess load on one side above the other would pass through the series coils of the more heavily loaded machine and increase its magnetic field, thus keeping its potential at a level with the more lightly loaded machine. Under similar conditions, of course, a shunt machine would lower its potential.

The next case we will take up will be one in which we have two over-compounded machines running on the three wire system, and one finds that however unbalanced the load may be, both machines will maintain a practically constant potential at any predetermined point if the compounding is correctly figured. One hundred and ten volt dynamos of such a type and under such circumstances would be the correct thing for incandescent lighting where the distance of lamps from the generating station does not exceed one-half mile, and where the cost of conductors on the 110-volt system and the cost of transformers on the alternating system would make these systems too expensive in comparison with the 220-volt system. A system of this kind would also be fitted for the distribution of power over short distances of, say, one-half-mile on the 220-volt and three miles on the 1,000-volt system.

The next case we will take up will be one in which we have compound-wound generators running in multiple on the two-wire multiple arc system. We find that the generators will compensate for internal reactions, but will not compensate for loss in transmission. Machines of this form, and running in multiple, would be but little better than straight shunt machines, one of the only advantages being that they would divide the total load among them more equally than shunt machines would under similar conditions.

The last case we shall take up will be one in which we have over-compounded generators running in multiple. The series winding will fairly compensate in the average manufacturer's machine for internal reactions due to varying load, and also when all machines are running for all variations in loss in the system due to varying load. It is this form and arrangement of generators for incandescent lighting, which is at present rightly popular for isolated plants.

We will now turn to a case in which this arrangement of over-compounded machines in multiple will not maintain a constant potential at the lamps. The case we will take will be one in which we have two or more compound machines running in multiple, and suppose we are running our feeders at 10 per cent. loss, and at some time we have but one-third of our total load of lamps on. Now it is poor economy to run two or more dynamos on a light load, when one can take the total load. Therefore, in practice, we would cut out all the generators except one, and in doing this we should find that the voltage at the lamps would increase considerably, for the reason that when at full load, with all machines running, our loss is 10 per cent. in feeders, and the voltage of lamps correct. When we cut two-thirds of the lamps off, our loss drops in direct proportion, and we have each machine taking its equal share of the reduced load, which share passes through its series coils, producing the correct voltage necessary to run the lamps at the new percentage of loss in feeders. When we cut out all machines but one, say, then the total current which was previously divided among all machines will be drawn from the remaining one, and, in consequence, will pass through its series coils, and thus raise the voltage at the lamps, because the percentage of loss in feeders has varied from 10 per cent. to the percentage of loss at one-third load.

This case may prove very serious with 110-volt lamps. On two-wire multiple arc systems, for instance, the voltage at lamps would vary from 110 volts to at least 118 volts. Of course, in this case, hand regulation with ordinary generators would have to be resorted to, and the only benefit derived from the compound winding would be the accurate division of load between compound-wound generators running in multiple and the practically automatic regulation obtained for varying loads with all machines running.

A solution of this problem of how to keep voltage at lamps down when all machines but one are cut out would be to

* A paper read before the Chicago Electric Club.

either wind the series coils in sections, and when machines are thrown out to short circuit a certain portion of each of the series coils of the balance of the generators or to operate a shunt of variable resistance, which shunt would cut down the current flowing through the series coils in direct proportion to the number of machines cut out. In addition to this, it would also be advisable to excite the shunt field spools of all machines from a separate exciter, run from an independent source of power from that which runs the generators themselves.

One finds in practice that few compound machines will maintain within 1 per cent. constant potential at any predetermined point, as a factor will creep in which it is almost impossible to provide for in the compound winding, and that is the heating up of the machine, which depends on the ventilation of the machine itself, on the ventilation of the dynamo room, and also on the temperature of the outside air. Therefore, in conclusion, it should be said that in general too much is expected of a compound or over-compound machine, and too few allowances made.

THE UTILISATION OF NIAGARA.

PROF. FORBES read his paper on the "Niagara Utilisation Works" before the Society of Arts on December 14th, and gave a very comprehensive account of this big undertaking. For the benefit of those who are not familiar with the features of the great fall, we may state that the falls exist at the extremity of a channel along which the river flows with great rapidity. At the falls, or rather below them, the flow is almost at right angles with the direction of the flow above the fall, and it is across the angle between the two portions of the river that a tunnel has been pierced at the level of the lower river to serve as a tail race for the turbines which have been selected as the means of utilising a portion of the water which has gone to waste so many thousand years at a rate more than sufficient to develop in 24 hours all the power at present used in the world. At the outset Prof. Forbes explained the reason for the extreme steadiness of flow which seems to characterise the Niagara river. Its gathering ground is of a total area of 331,235 square miles, of which 90,000 is lake surface. Assuming a similar rainfall with that of the British Isles, the area of which is 120,000 square miles, it would appear that all the rivers of our own country are barely equal in flow to Niagara, the volume of which has been estimated at from 265,000 to 311,500 cubic feet per second. With a lake area of 90,000 miles, the effect of a flood in Lake Superior watershed sufficient to raise the level of the lake nine inches would require six months to reach the falls.

Between Lakes Erie and Ontario the difference of level is 336 feet, of which 15 feet occur above the rapids, which account for 55 feet. The fall itself is 161 feet, and below them is a further 105 feet to the lower lake. The fall actually utilised is, however, only 140 feet, or equal to an effective horse-power of 3½ millions. Of this the Construction Company propose to provide for using 100,000 horse-power with the present tunnel, and they have powers to construct a second similar tunnel.

The method employed has been to make a canal 1,500 feet long, 500 feet wide, and 12 feet deep from the upper river 1½ miles above the fall, and alongside this canal are a number of pits 160 feet deep, to contain the turbines to which water is admitted from the canal. The tail race with which all these pits communicate is the tunnel 6,700 feet long under the City of Niagara to the lower river. This tunnel has, of course, been the most important part of the undertaking, and has been necessary in order to secure a fall, this having been the one difficulty in the way of utilising Niagara very greatly in the past, for to do so the steep sides of the lower gorge have alone afforded mill sites. The new tunnel, 19 feet by 21 feet inside its brick lining, has a cross-section of 386 square feet, and was cut in limestone and shale of such a character as to call for lining throughout. About 30 acres of land was reclaimed from the river by means of the spoil, and this is being used by the Niagara Falls Paper Company, who lease from the Construction Company the use of the tunnel, and have sunk their own wheel-pit for 6,000 horse-power of turbines. The Construction Company have already sunk a pit to accommodate three turbines of 5,000 horse-power each. They revolve at 250 revolutions per minute, and are of the Girard type, designed by Fœsch and Piccard, of Geneva, to be constructed in America. It is a little curious to note this, because the types of turbine used in America have always been condemned as wasteful of water by European engineers, and yet have been claimed in America as having an efficiency higher than the best makers of Europe care to guarantee. No reasons are advanced for the adoption of a European design.

It would appear from the paper that the spindles of the dynamos are to be simply the vertical spindles of the turbines, but beyond this no particulars are given as to the driving of the dynamos, nor is it definitely stated that such is the case, the paper being strictly reserved on this matter, for we are told that nothing is decided yet, even, as to the mode of electrical transmission, the only difficulty, however, being to select from the many offered schemes, some twenty distinct plans being proposed for the 5,000 H.P. generators, the chief difference being in the proposed weights of the revolving parts, from 7 to 60 tons, though it is stated as remarkable the comparatively small difference of opinion between electricians as to the general means to be employed. Prof. Forbes has an open mind himself, and would gladly accept anything which seems more valuable than what he has yet received, and he holds the balance very fairly between the continuous and the alternating current system, and their respective advantages or otherwise. He considers that the range of transmission practicable with low pressure and thick conductors is very limited, and considers that the Frankfort-Lauffen experiment has sufficiently proved the safety and possibility of using 20,000 volts in transmitting between Niagara and Buffalo by means of a subway open to easy inspection. At present, therefore, he would favour alternating currents for the supply of Buffalo, transformed up to and down from the high pressure transmission main, and he states that the non-synchronising alternating motor, especially of the rotary phase type, are guaranteed by their makers to have an efficiency of 90 to 92 per cent. Satisfied as to the electrical possibilities of the scheme, the commercial side is stated in general terms unhesitatingly as secure, the cost of a horse-power at Niagara Falls or at Buffalo being low enough to make the enterprise certain of success. When we are informed that the consulting engineers include Mr. Coleman Sellers and that most genial of engineers, Mr. Bogart, as well as Mr. Clemens Herschel, of turbine testing experience, we may conclude that the engineering should be sound.

It appears that a concession has been granted on the Canadian side of the river for powers to use the Horseshoe fall to the extent of 250,000 horse-power. It is intended, if possible, to develop 1,500 acres of land in the vicinity of the falls as a site for a great manufacturing centre, and it is hoped that this may become one of the greatest manufacturing centres in America. This is a hope we do not share; we should much prefer to see the science of electrical transmission so developed, as to render such a concentration of industry wholly unnecessary. This is, in fact, one of the ends to which electricity is best put, and it seems undesirable to confine this water-power to its immediate locality. Why bring copper refineries to the spot, or wire mills; or why discuss the question of transformers and high pressure, if the power of Niagara is not to be diffused. Is it not the concentration of industries which has made our manufacturing towns so hideous, the avoidance of which it is hoped by so many will be accomplished in time by electricity.

Putting the value of a horse-power at £5 annually, the American and Canadian concessions together would have an income of 2½ millions annually; this for a horse-power day and night the year through.

Reckoned upon a coal consumption of 2 lbs. per hour, the annual cost of a horse-power in coal at 10s. per ton is about 70s. for large powers. Prof. Forbes's £5 would be well enough for users of small engines, but it would not pay a large user. A 1,000-horse steam plant night and day would not cost £5,000 per annum in coal, wages and interest even at 10s. per ton, whereas 5s. is often nearer the mark; but we may hope that a less charge than £5 could be made to large users, and we have, indeed, understood this will be as low as 21s., while a small user could well afford to pay much more. Prof. Forbes concluded with a growl at the Govern-

ment of Ontario who have spoilt the Victoria Park, on the Canadian side of the fall, by a concession for a brutal railroad, with hideous bridges, so destroying the beauty of the place which Lord Dufferin did so much to secure, it was hoped in perpetuity.

Naturally, too, he commended the foresight of the directors of the company to whom he acts as consulting electrician. A paper descriptive of a well-considered scheme like this does not admit of much discussion by the listeners, and nothing of importance was advanced; but it was elicited that the velocity of flow in the tunnel would be 25 feet per second, a rather rapid rate. We should have been glad, of course, to have had further information as to the size of the turbines which, with a speed of 250 revolutions per minute, would seem to be of rather small diameter for so large a power and, consequently, of great breadth of face. Even if reticence be still needful in regard to the electrical portion of the scheme, the hydraulic machinery already constructing would, if more particularised, have greatly added to the value of the paper at a time when the utilisation of water-power seems to be attracting special attention.

A FUTURE FIELD FOR COAL GAS.

UNDER the above head appears a small pamphlet reprinted from our contemporary *Lightning*. It consists simply of a few letters from gas engineers pointing out how an increase of consumption may be brought about. One of the favourite means suggested is the use of gas for domestic purposes, as cooking, &c. The gas companies themselves do now supply stoves for cooking purposes, but we fear either that gas is wholly useless for such a purpose, or that the stoves supplied by the companies are made purposely wasteful, for no average householder could afford to use gas in place of coal. A case was recently brought under our notice of a house rented at £40 only where gas cost £32 per annum. One of the writers, Mr. P. Boulnois, makes one of the best suggestions—that gas companies should drop their idiotic and vexatious habit of demanding filled up forms and declarations, a huge deposit which must represent many thousands of pounds filched from householders, and a general habit of abuse and incivility which has grown into a sort of second nature with them. They might, also, with credit to themselves, do something regarding that mechanical Ananias which is called the meter on *lucus a non lucendo* principles. Naturally Mr. Thomas Fletcher writes favourably of gas heating, for he sells gas appliances, but we wonder he can state it is cheaper than coal in a house.

Mr. Boulnois advises improved burners; Mr. Lea condemns them. We have no means of knowing how they will endure; but there is now an incandescent gas light in large use in London which so far as appearances go, is better than anything yet appearing electrically; and if its durability equals its brilliancy, it will be a powerful competitor of electricity; but we are ourselves doubtful of the durability of the one expensive part of this excellent burner.

There is certainly a field open for gas as a motive power. In the case of a private electric installation, we recently found the consumption of the gas engine to be one-half what had previously been burned for lighting purposes.

Despite all that may be done, gas lighting must give way to electricity, unless the gas companies can contrive to have new houses built with proper flues to lead away the products of combustion. In old houses, they will have to pay for such pipes or flues being constructed, if they wish to retain business. As regards London, the gas companies, having always had the competition of oil and candles, have never, so far, given way to dishonesty as have the water companies. It is certain that the illegal charge made by one water company for a bath for years past has prejudiced the public so far that no hand would be raised to save the water companies from confiscation by the County Council. The humble competitive candle has saved the gas companies from this; but what have they been doing all these years, that they have required to even own that the tallow dip did compete. It is, after all, the electric light which has been required to stir up the gas companies, and it is not a little amusing to find our contemporary bolstering up the gas industry. Gas has its own proper field of employment, and ought to be sold at less than half its present price, and could be so sold at a profit, even through a George Washington meter, were the gas companies to put that energy into their business which ordinary people do into their affairs. Unfortunately for the public, they have preferred to cover their delinquencies in that direction by over-charging a too-frequently falsely measured quantity of an inferior article, improperly purified.

THE GROUND RETURN.*

IN the course of the discussion at the recent meeting of the American Street Railway Association at Cleveland, Mr. F. S. Pearson, chief of the steam and electrical department of the West End Street Railway Company of Boston, brought up some points in reference to the ground return which, from his long experience in this line, should prove of interest to practical men.

In small towns and systems where there are few cars running, Mr. Pearson thinks the ordinary method of returning the current through the rails and supplementary wire is sufficient unless the distance is great. On large roads where the traffic is heavy, more return grounds than have been used heretofore will have to be installed. It was found so in Boston, and from lack of return feeders a great deal of electrolytic action was caused in the supplementary wire, and the West End Company is now putting up a large amount of overhead copper for return grounds, since the underground will corrode and rust away. There is no advantage in using iron, as the conductivity is only one-seventh that of copper. Originally the positive current was run through the trolley wire, but it was found that the action on the supplementary wires was too great, and so the negative was put to the trolley wire. It was not thought that there would be much less effect, as it merely transfers the action to another point.

In reference to water pipes, Mr. Pearson said that he did not have in mind any particular trouble with water pipes, but naturally, if there is a large volume of current going through the earth, it will take hold of a water pipe or a gas pipe, or any other pipe, and there will be an electrolytic action set up; and in any large railway system, if the attempt is made to use the earth for return ground by putting in ground plates in driven wells, or by putting them in the rivers, and the return current is not provided with a good metallic circuit, the current must inevitably injure the water pipes and all other pipes. The current, when it leaves the car, goes into the ground, and, taking a water pipe, may go a mile on that pipe, then leave it for a better conductor, the result being that the pipe will be corroded at this latter point.

As to using old rails for a return, the difficulty is to make a good joint. If the rails could be welded or soldered this plan might work, but the joints could hardly be made in any other way so that they would carry the large volume of current without heating or corrosion. To joint the rails by copper plates would be a poor construction, as the iron and copper would form an electrolytic element and cause corrosion, even if no current was passed through the joint. The passage of the current would also heat the joint and cause further oxidation.

In the early days of electric railroading an attempt was made to use the rail for a return current and not put in supplementary wires, but it was found almost impossible to maintain a joint of any sort. When a large volume of current is sent through the joint oxidation takes place, and the joint soon becomes worthless. This condition will exist no matter how large the joint is made, and if dissimilar materials or metals are used, a local electrolytic action will also take place. With steel in contact with iron the effect will be produced in a lesser degree than with copper, and it will take longer for the trouble to develop.

Old steel and iron cables had been used in the crossing of rivers and for connecting the supplementary wires from one side

* New York *Electrical World*.

of the track to the other, but the objection to the cable is that it cuts away very fast. For instance, in one place seven ropes or cables have been put in and soldered thoroughly at each end, and in less than four months they were entirely gone. If the soil was comparatively dry and sandy this scheme might do for a while, but where it is moist and solid it is a question whether the cables will last long enough to pay for putting them down. As a rule, in track construction to-day the West End Road uses supplementary wires as well as bond wires on the rails, the former having a low resistance as compared with the bond wires and joints. The greater current passes on the supplementary wire and does not go through the joint. If the supplementary wire is cut and all the current is made to pass through the bond wire there is trouble, but as long as a good supplementary conductor is maintained the current will not pass through the bonded wire, the joints will remain cool, and there will be no great tendency to oxidation, especially if tinned rivets are used.

AN ELECTRIC BELLE.*

By L. H. TUPPER in New York "*Truth*."

Miss Gretchen Van Tassel belonged to one of the oldest Knickerbocker families in Harlem.

Mr. Edouard Constant belonged to one of the most ancient Huguenot families in New Rochelle.

Miss Van Tassel traced her ancestry back to the Van Tassels, burgomasters of Medemblik in the days of Van Dyck. On her mother's side she was distantly of kin with the Schimmelpennincks.

Mr. Constant, in retrospective moments, followed his ancestry back to Richelieu; not the Cardinal, but the Cardinal's uncle. The Constants came from Vichy, Department of Allier, and were older than the springs.

Albeit these young people were ancient in their origin, they were modern in their tastes. For both were enthusiasts in science. Each had a brilliant fad—Electricity!

Miss Van Tassel contributed bright articles to the *Electrical Review*. She took her work very seriously, for she thought that electricity was not a subject to be made light of.

Mr. Constant was an amateur whose opinion was highly valued by the Board of Electrical Control. It often invited him to throw some light on the subject of street illumination. He was a very magnetic man, and would have been highly successful in politics had he, like Mr. Bagehot, joined politics to physics. His speeches on electricity were luminous in argument and corruscated with wit.

One sunny afternoon Mr. Constant heard the telephone bell jingle in his office.

"I suppose they want to consult me at the Board of Electrical Control," said he.

"Hello!" came a sweet voice.

"Hello!" said Mr. Constant, with great uncertainty.

"Are you the Board of Electrical Control?" said the sweet voice confidently.

"I am the technical knowledge, the precise data, and the opinions of the Board of Electric Control," said Mr. Constant modestly. "Pray, who are you?"

"I am Miss Van Tassel—"

"Not Miss Van Tassel the author of 'The Sun as a Solar Battery?'"

"Yes."

"Oh!"

"And you?"

"Mr. Constant—"

"Not Mr. Constant the writer of the profound essay on "The Electrical Energy of Ether on Space?"

"Yes."

"Oh!"

Just at this moment the central office severed the wires.

"That 'oh!' was delicious," said Mr. Constant.

"What awe and admiration in his 'oh!'" thought Miss Van Tassel.

The two electricians were soon carrying on a charming courtship by telephone. Cupid, like a rope dancer, travelled by wire. He wore the wings of lightning and carried a quiver full of electric arrows.

One day Miss Van Tassel telephoned to Mr. Constant that she had encountered a problem in electricity that was "too awfully deep for anything."

Mr. Constant chivalrously offered to assist her to solve the problem, and received an invitation to call at her house.

The following evening Mr. Constant polished his shoes by electricity, parted his hair with an electric comb, smoothed it with an electric brush, and then started uptown to call on the fair electrician, with whom he already had a slight acquaintance by telephone, by telegraph, and by "lightning district messenger."

He stepped aboard an electric street car of the Madison Avenue line and rode through avenues illuminated by electric lights. So brilliant were the Brush lamps that he was able to read the *Electrical Engineer* as he stood on the front platform of the car, which the storage batteries were driving merrily along.

As he tripped up the steps of Miss Van Tassel's home he observed an electrical storm in the sky. He brushed his feet on the electric door mat, and then rang the electric bell. A wide-awake maid servant pressed an electric button and the door opened. Mr. Constant was ushered into the drawing room, which was kept agreeably warm by an electric stove, and was softly illuminated by mellow electric lights.

Miss Gretchen Van Tassel fluttered into the drawing-room. Her golden hair was like the pale golden light of an Edison lamp; her eyes sparkled like a Leyden jar. She extended her tiny hand. Mr. Constant felt the electric touch of her finger tips. On her hand a pure white diamond shone with electric fires.

They talked pleasantly about electro-magnetism, alternating currents, positive poles, magnetism in politics, "the Georgia Electrical Girl," incandescent lights, live wires, and other living issues. Miss Van Tassel's enthusiasm was electric. Suddenly she paused in her conversation, drew aside the window curtains and said: "See the electrical phenomena in the sky!"

Mr. Constant and Miss Van Tassel walked out on the veranda and enjoyed the play of colours of the aurora borealis. The northern sky had organised a *fête* in honour or their happy meeting.

Mr. Constant was a frequent visitor at the happy electric fireside of Miss Gretchen Van Tassel; her home was a magnet which drew him irresistibly. Often the electric lamp in the drawing room was turned low, and the two talked in soft electric whispers.

Soon the happy Harlem sparrows held meetings on the telegraph wires and gossiped of the approaching nuptials of Edward Constant and Gretchen Van Tassel.

The marriage was celebrated this week at the bride's home. All the society people who move in the best electrical circles were present. As the bride and the bridegroom entered the drawing-room, they were welcomed by a chime of electric bells. Then an automatic electric piano played the wedding march from "Lohengrin." In her golden hair the bride wore a comb arched with tiny electric lights that shone like diamonds.

All at once many beautiful bouquets in the room became luminous and shed a rare radiance. They had been suddenly illuminated by many little electric lights concealed among the roses.

The happy pair stood before the minister. The words were spoken, there was an electric kiss, and the continuous current of their happiness had begun.

* New York *Electrical Review*.

The Recent Fatal Accident.—Regarding the letters which have appeared in the Review on the death of T. P. Lang, we understand that a claim is being made on the House-to-House Company for compensation on behalf of the widow for the loss of her husband. Mr. Alfred Slater, the solicitor to the friends of the deceased, desires to obtain assistance from those interested, and perhaps our correspondents who have written us on the subject will kindly communicate with him at 70, Finsbury Pavement, E.C.

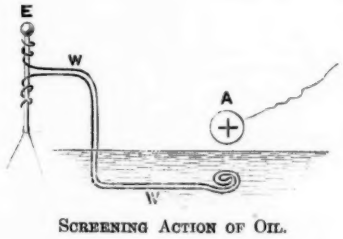
ELECTROSTATIC SCREENING AND INFLUENCE MACHINES.

BY J. E. TAYLOR.

AN account of some incomplete experiments on the immersion of a Wimshurst form of influence machine in paraffin oil was given a short time ago by the writer in the ELECTICAL REVIEW. The experiments had then to be postponed to allow of a mechanical alteration of the machine in order to obtain, if possible, a greater speed of rotation of the plates, and also to allow of the plates being fitted with sectors, as in the ordinary form of Wimshurst. Contrary to expectations, however, these alterations do not give any improvement on the primary form, and it is not possible to get a high speed of rotation in the oil by any convenient means on account of the fluid resistance to rotation. The machine can only maintain itself in action, after being excited for a very short time when rotated at its highest speed, and it then has no surplus charges available for use.

The failure lies in the slight conductivity of the oil, and it is extremely probable that no oil or liquid has sufficiently good insulation resistance for the purpose. If the only effect of this conductivity was to partially discharge the sectors whilst travelling from one point to another, the machine would certainly have proved effective, for the oil at the same time very materially reduces the rate of leakage from the various parts of the machine due to glow and brush discharges which take place so freely in air. The main cause of the failure is doubtless the screening off of the induction between the two plates by the intervening oil layer. Such screening off would, of course, be as fatal to a Wimshurst as to any other form of influence machine, and it is doubly effective, owing to the low speed of rotation obtainable.

This screening effect of the oil can easily be demonstrated by the aid of an electroscope and electrified body, as follows :—A doubled gutta-percha covered wire, W W, made into a flat spiral at the bend, is connected to the electroscope, E. An electrified body, A, causes a large divergence of the



SCREENING ACTION OF OIL.

leaves when at a certain distance from the spiral with air intervening. When the latter is covered with oil, however, only the slightest instantaneous divergence is produced. The wire, W, is not allowed to come in contact with the oil, because the microscopic charge induced on the electroscope is very soon got rid of through the conduction of the oil when such is the case.

As previously stated, this screening is due to a certain amount of conductivity, and the extremely small conductivity which will produce the effect, is well shown by the screening power of a clean dry glass plate introduced between an electrified body and electroscope. The conduction takes place over the surface of the glass (or in fact of any other solid insulator), and whilst this conduction is taking place the divergence of the leaves at first quickly and then gradually subsides ; the time taken being proportionate to the surface resistance. In any case after a short time has elapsed, the practical equivalent of an earth connected metallic sheet between the two is produced. On suddenly removing the electrified body a fresh divergence is produced due to the rise of potential on the surface of the glass, which subsides in the same manner as the first divergence. On rotating the glass plate in such a manner that a fresh surface is being continually brought into the field, a large divergence is at once produced, the quicker the rotation the greater the divergence due to the conduction over any one part not having time to act. A rapidly varying or moving charge has of course the same effect. A glass plate having one of its surfaces covered with paper is a nearly perfect screen when the induction is steady, but on rotation a considerable divergence depending on the speed of revolution, is obtained. To get the best results the paper ought to be put in connection with the earth at every point of its surface when away from the electroscope. From these results it can safely be inferred that a thin metallic coating on the glass would fail to screen at a very high speed of rotation, and thus we would have a metal acting in precisely the same way, for an instant, as a dielectric—a fact which has a not unimportant bearing on the theory of lateral transmission of electric energy. In the case of a moving or varying charge, Dr. Lodge has already detected this effect with a very thin silver coating on glass, but he appears to connect it with the opaqueness or transparency, as the case may be, of the deposited coating.*

The theory of this screening action is perhaps best considered by regarding the lines of strain which indicate the electrostatic strain existing between the electrified body and the earth. Such strain passing through the glass is gradually cut off by the dying out which takes place on the surface of the glass, thus gradually establishing an earth-connected surface between the electroscope and charged body, which of course short-circuits all the lines of strain.

Some interesting experiments may be tried on an ordinary Wimshurst machine by taking away say the two top brushes and connecting the two lower ones together, and then varying their relative positions. Allowing the two lower brushes (one back and one front) to retain their positions, the machine will excite itself, but the charges on each plate will alternate in sign, the back plate being positive whilst the front is negative, or *vice versa*. That such is the case can easily be seen in a darkened room by the character of the glow and brush discharges. The alternations occur at, or very nearly at, each complete revolution of the plates. Shifting the position of one of these brushes, beginning by taking it further away from the other and moving it round the plate, we get the following results. The alternations are kept up until we get the brushes at opposite ends of a diameter, but become rapidly feebler ; at this point they have ceased altogether, no action taking place. Going further round with the movable brush the machine again excites itself, but with a different action. Apparently either both brushes are positive or negative at the same time, or the charges simply rise and fall with sign constant. This action is much feebler than the first, and after arriving at a maximum at about the same relative positions of the brushes as the former, dies out when the brushes come over one another. These actions can be explained by taking into account the loss of charge by the sectors whilst travelling round the plates, which causes first one plate and then the other to act as inductor.

SATURNIAN SCIENCE.†

THE golden days have come back to us with their charming simplicity, untrammelled by any vulgar sense of responsibility, and it is to our esteemed contemporary, the *Saturday Review*, that this apotheosis of the beautiful, the vague, the inexact, and—not to put too fine a point on it—the silly itself, has been brought about. Last week it contributed to the gaiety of nations by the discovery of a new and noteworthy class of bacteria known to it as ptomaines, and in the current issue it is pleasingly apocryphal in the matter of magnets. Note its *ipsissima verba* on this topic, which for it to touch is to adorn. Anent the responsibilities of rich men who might with ease undertake researches, scientific, archæological, and literary, debarred to their legitimate prosecutors by lack of pence, it relates :—"We have heard indeed of a bold and costly undertaking which an eminent personage, still living, projected in his youth. He caused a magnet to be built of such size and power as had not yet been imagined. It was his intention to charge this gigantic object without witnesses, so as to enjoy the unparalleled result in selfish solitude.

* See "B.A. Reports," 1889, p. 510.
† *Industries.*

Happily, a great authority called at the moment, and received an invitation to assist. When he saw the preparations his face paled. Neither he nor anyone else could foretell what would happen if that 20-foot magnet were set to work; but it was probable, at least, that the house would fall. The thing still remains uncharged—or did a few years ago. But it is not recorded that this gentleman has devised any such scheme since he came into his patrimony."

Let the reader observe the realistic character of this narrative and its dramatic culmination. In the first place, the magnet—nature not stated—was made. Then it was to be "charged," as if it were a grand jury or a Leyden jar. It was, moreover, to be charged in solitude from motives of pure selfishness; the "man in the street" should presumably have been asked in to assist. Next upon the scene comes a "great authority," whose advent so works upon the feelings of the owner of the prodigy that he is forthwith invited to stay and help. But he is not a man of nerve. He knows not of what to be afraid, but his alarm is very genuine, and he shrinks from the *rôle* of Frankenstein to a monster of such enormity. Visibly blanching at the rashness of his opulent friend, he dissuades him from meddling with what might prove a veritable petard, and bring the house about their ears. So the huge engine remains a monument of wasted endeavour and timous timidity, and to it can be tacked a tale and a moral more or less apposite. Contrast this romantic exposition with the bald statement that would be offered by anyone encumbered with a rudimentary knowledge of the ways of magnets—viz., that the eminent personage perceived a fatal error in the design or construction of the instrument, and spared the feelings of the wealthy one with diplomatic adroitness by simulated terror.

LEGAL.

NATIONAL TELEPHONE COMPANY *v.* GRAFF-BAKER.

High Court of Justice.—Chancery Division.

(Before Mr. Justice Kekewich.)

(*Continued from page* 734.)

FIRST DAY.—DECEMBER 13TH.

Counsel for the plaintiffs: Sir Richard Webster, Q.C., M.P., Mr. J. Fletcher Moulton, Q.C., Mr. C. M. Warmington, Q.C. Mr. N. Micklem, and Mr. R. W. Wallace, instructed by Messrs. Waterhouse, Winterbotham and Harrison. Counsel for the defendant: The Solicitor-General (Sir John Rigby, Q.C.), Mr. W. Rr. Bousfield, Q.C., M.P., and Mr. Alfred Durham, instructed by Mr. Clarance Leighton. Mr. Morton Daniell, instructed by Mr. F. W. Kite, held a watching brief on behalf of the Thomson-Houston International Electric Company.

Dr. JOHN HOPKINSON, cross-examined by Mr. BOUSFIELD, said there were many hundreds of miles of electric tramways in the world, the larger portion in America. Probably it was the fact that nine-tenths of the electrical tramways in existence were worked upon the system which the defendant had adopted at Leeds. He would not say that that was the most approved system, although it was the most largely adopted. If it were put to him to lay out a tramway in Leeds he should adopt substantially the system adopted in Buda Pesth. For a change of that sort at Leeds the generating plant would remain the same, but they would have to completely alter the system of conductors. The slot in the rail leading to the conduit at Buda Pesth was 33 millimetres, or 1¼ inch wide. That could be diminished to about an inch. That would not decrease the efficiency of the system. They had no trouble at Buda Pesth through the wearing away of the insulation of the hanger through coming into contact with the sides of the slot. The wheels of a bicycle could get into a slot an inch wide; they were sometimes much injured by getting into the groove of an ordinary tramway. He did not know that in England the Board of Trade did not permit the use of a slot an inch wide. The working of the tram would not be seriously interfered with by water getting into the conduit, for there were means provided for draining it off. He had not heard that in Buda Pesth water getting into the conduit had stopped the working of the trams. The line at Vevey was a single conductor one, with a number of passing places. That system would be applicable so far as the tramways were at present arranged at Leeds; the Vevey system was a much larger undertaking than that at Leeds, where they had about 3 miles only on the outskirts. No doubt the fact that they proposed to extend it to the more crowded parts of Leeds was the operating cause with the Telephone Company to take this action. He had not thought much about the Vevey plan, but he had no doubt that the Buda Pesth system could be applied to a complicated crossing such as that at the end of Boar Lane, in Leeds. In a system of double overhead conductors wherever there was a crossing of any kind, it was necessary to have two sets of conductors on one line crossing the two sets of the other. It was necessary that there should be sufficient distance between them, otherwise there would be sparking and other difficulties, and there were gaps in the conductors at certain points where it crossed at the same level. There was a breach of continuity of the conductor, and the shuttle reached over from one side to the other of that breach of continuity. (A model was put in of the crossing at the end of Boar Lane, Leeds, arranged to show the wires necessary for a double overhead system of conductors.) Witness said he made out six crossings where they would have a break. He should so arrange his lines in such a case that the breaks would always be bridged over.

Mr. BOUSFIELD: I ask you whether it is not absolutely necessary that the car should not cross upon a number of points where it would have to stop, and could not go on without somebody pushing behind it?—No; I think you could get over it.

Do you know of any place where a complex corner has been worked out successfully in practice upon any system except the one the defendants have adopted?—Yes, at Buda Pesth.

Do you know of any case where the system of double overhead conductors, either in the Vevey form or any other form, has been successfully applied to a complicated case of this kind?—No; neither successfully nor unsuccessfully. The only case of overhead conductors and an insulated return that I know of is Vevey, and in that case, as far as I remember, there is nothing but mere branches, which, of course, does involve a difficulty in an elementary form for the purpose of passing the cars.

The system at Vevey does not give immunity from noise in the telephones, does it?—Not absolute. I listened at the telephones there, and in particular I listened upon a telephone which belonged to the tramway company. In that case the wire was carried upon the same posts as the two conductors, and the distance between the two was comparable with the distance between the two conductors, and in that case there was disturbance, but not so bad as at Leeds, even then.

Is it not a fact that in London itself you constantly get disturbances in the telephone system which are quite as bad as the noises you heard at Leeds?—I did hear a disturbance caused by the Grosvenor Gallery installation some years ago, which may have been about as bad. In that case they had an open circuit. We complained, and they duplicated their circuit, and cured it. In the ordinary course of things I have never heard it so bad.

Is not it the fact that in some districts in Leeds, where the working is quite out of the sphere of the noise and the working of the tramway, there are disturbances in the telephone as great as those caused by the tramway?—I never heard of anything of the sort, and I should doubt it very much indeed. I do not believe it.

What distance should you think that the noise of this current along the tramway would extend laterally?—Of course it diminishes with distance, and it narrows as the length of the two lines run parallel with each other, so that it is a question of degree.

Can you give us an idea of how far the tramway wires should keep from the telephone wires?—I should say, taking the portion where you run parallel from Gledhow Road to the line going up to Chapeltown, if you put it at 20 feet apart, the disturbance would be so slight, that it would not be very appreciable.

If your wire were put at the backs of the houses, where there happen to be houses, instead of along the fronts, that would remove the disturbance?—Yes.

If your wire ran 20 feet off, that might possibly remove what is complained of?—It would very largely diminish it undoubtedly; whether it would remove it or not, of course I can hardly say.

In some cases you may have the bulk of the telephone current passing through the water pipes?—It is quite possible.

And in that case, by having the water pipe portion of your circuit close to the earth portion, as I may call it, of our circuit, the disturbing effect by induction would be very much increased?—I can hardly see how that could be. In this case it could not have been so.

I suppose one may say that the telephone is perhaps the most delicate instrument in existence for detaching stray vibratory currents of electricity, or variable currents of electricity?—Yes, that is so.

Is it not a fact that the telephone without a metallic return is an extremely imperfect and unreliable instrument?—No, I would not say it was imperfect or unreliable. You do hear a certain amount of disturbance from parallel lines, undoubtedly; but not so great as to cause any insuperable trouble.

If you go on the same poles as a telegraph wire, you are apt to get a disturbance?—And for that reason they rarely go on the same poles, but when they do they are always used with an insulated return.

Is not the proposition which I was putting to you so well recognised, that in every case where Her Majesty's Government erect telephones they invariably use a metallic return, and not an earth return? That I cannot say. All I can say is that they have a telephone exchange under the control of the Post Office at Newcastle, and there they have both wires insulated.

Do you know that the New Telephone Company, which recently started as a rival to the National Telephone Company in Manchester, have also adopted that system?—I do not know to what extent their wires have gone up; I know they spoke of doing so, but what was actually done I do not know.

Is it not now generally recognised that if you want a reliable telephone for commercial purposes you must have a metallic return, and not use the earth?—By no means. You may put it as high as this, that if you want to have a telephone system in which you can hear absolutely no sound except the voice of the person speaking to you, you must do that; that is to say, with a large, extensive system with many parallel wires.

In all cases where the plaintiff company have a long distance to work they themselves use a metallic return?—Oh, yes; especially in cases where they run along the railway, and consequently are open to the conductor disturbances of the telegraph wires.

It is perfectly simple, is it not, and feasible, to have part of your system furnished with metallic returns and part with earth returns?—There are drawbacks in doing that, but it is possible.

I will just put this case. Supposing A is a subscriber and B another subscriber, and D the exchange. If A wants to speak to C in Leeds, the normal way is for him to be connected with the exchange so that the current goes through the wire to the earth plates, and then through the earth to the water-pipes?—Yes.

Supposing the line from B to C is disturbed, and passes along the tramline, then instead of carrying C to earth close to his office, you can duplicate C by carrying him back towards B, and carrying to earth near B, so that by that duplication along that disturbed area you will cut out the disturbance along that part?—Yes.

You would still have him to earth, and you would still be able to work him in the ordinary way on the exchange with the ordinary switchboard?—Yes.

So in this way it is perfectly possible to work a system of partial metallic returns in conjunction with the ordinary earth plates?—In a small district like this it would be so.

So that at a comparatively small expense the telephone company could in that way make the system efficient, notwithstanding our tramway system?—I can hardly give you an estimate of the expense. It would not be gigantic, I agree.

Our return is not an earth return, is it? It is our leakage that you complain of?—Yes. You have the rails, and you have in addition to them No. 4 stout copper wire laid without insulation in the earth and connected with those rails.

So that 99·9 per cent. of our current would pass along that conductor and not pass into the earth?—I could not put any figure upon it, but no doubt a large portion of it will go back to the rail.

So we do not rely in any way upon the earth for the efficiency of the system?—No; I have tried to state that without the earth I think you could have a better system than you have.

Whereas you do, in fact, rely upon the use of the earth at present for your system?—Entirely.

You attribute some of the disturbance to the variability of our contacts, and you say that the trolley, the fishing rod, as you call it, with a little wheel on the end of it, shakes, and the contact varies between that and the overhead wires?—Yes.

Supposing you unship the fishing rod and connect it by a long, loose, rolled up conductor to the top of the tramcar from the line, say 100 yards long?—I follow you so far, but what are you to do with the long wire?

Fasten it to an overhead conductor and also to the motor of the car. Then fix the earth plate of the motor to the other long wire, and the other end of the long wire to some point on the rails. Then you have a metallic circuit without those variable contacts of which you complain?—Yes. You eliminate two of the causes to which I alluded.

That experiment has been made, and if, as a result of that, there was no appreciable difference in the sound, then you would say that your suggestion as to that being the cause of the disturbance could not be true?—Well, of course you say there is no appreciable difference, and I should say the principal resistance of sound might be due to the contacts on the commutator. I tried what is substantially the same experiment the other day with the dynamo machine, which was on a very good foundation, and in very good order. I took the current on that dynamo and on the transformer, and listened on the secondary circuit of that transformer, and telephoned, and we could hear it.

Coming to the rhythmical interruptions of the commutators, that is a thing you cannot possibly get over, is it not?—I do not think you can.

That would be the same with a steady continuous electric light current, would it not?—If produced by a dynamo machine. I say I think you could not get over it, but I have no doubt you might, to a large extent, get over it if you used accumulators, or something of that sort.

It is suggested to me that you suggested that the alteration of our system from the conduit system can be made at a trifling cost. Did you make that suggestion?—Not that you could now alter at a trifling cost, but that the cost would not be very great. If you had started *ab initio* with the conduit it would have cost you more, but not so very greatly more. Of course, now that the thing is done, it would cost a great deal more, because the whole work would have to go down again.

Is it not a fact that the cost is about £2,000 a mile for making a tramway on the conduit system?—I think it would be of that order of magnitude.

Do you not know that the Board of Trade rule is "The electrical pressure or difference of potential between any suspended conductors and the earth, or between any two such suspended conductors, shall in no case exceed 300 volts"? If that is so, that would do away with your suggestion upon that point?—I had a case in my mind when I was considering whether it could be done or not, and I ascertained from the Board of Trade that if an application were made to them to do this—that is, to take 600 volts, both being insulated—they would regard it with favourable consideration. The existing rule, of course, precludes anything beyond 300 volts between the two. I may give you an example. In Manchester, at the present moment, we are laying down electric lighting plant to work at 400 volts, and all they require us to do is to keep the middle of the 400 volts at earth pressure, so that you have then 200 above and 200 below, which is an exactly analogous case to this.

That is under a special clause in the Act?—No; it is done with the special sanction of the Board of Trade. We had to apply to them for sanction, and we got the sanction—that is all.

Re-examined by Mr. WARMINGTON: Whatever may happen in the future, the model put in does not represent any actual position in Leeds where an electric tramway is at work?—Oh, no; at Leeds, the problem to be solved is a vastly simpler one than even that at Vevey, and beyond all comparison simpler than that at Buda Pesth, where there is really a very complicated system of tramways.

There would be no difficulty, so far as Leeds is concerned, in applying either system?—No; it would be perfectly easy at Leeds to apply any one of the plans to which I have referred.

The Court then adjourned for the day.

SECOND DAY.—DECEMBER 14TH.

Lord KELVIN was the next witness called, and was examined by Sir RICHARD WEBSTER. He said he knew of no cases in this country, except the Post Office part of the telephonic system in Newcastle, where metallic returns were used for telephonic circuits. The larger part of the telephonic system in that town, that owned by the National Telephone Company, was on the single-wire system. Paris was the only place in Europe, so far as he knew, where a double wire was used. In Berlin, there were 17,000 subscribers on the single-wire system. Overhead wires were not allowed in Paris, and that was the reason the double wire was used, the lines being laid in troughs. He went to Leeds on June 3rd for the purpose of examining into the disturbances in the telephones there. He first listened at the central station of the company at Commercial Buildings, and afterwards at the Roundhay call office. The disturbance was very severe, and the starting and stopping of the tramcars could be heard perfectly. There was a humming sound, which he believed was due to the dynamo; there was also a rough sound, and, altogether, a very loud roar during the time the tram was running, so much so, that it made conversation almost impossible, he thought for ordinary subscribers quite impossible. In his opinion, the disturbance would interfere very seriously with the commercial usefulness of the telephone. The causes of the disturbance were the changes of the strength of current, and an electrification of the wire or wires of the tramway system. He was acquainted with the defendant's system, and believed that system likely to produce serious disturbance. The connection by trolley was objectionable, because there was a varying resistance between the wire and the trolley. The wire was not perfectly rigid, but hung by steel hangers and sagged somewhat, so that there were varying degrees of contact between the trolley and the wire. There was also a varying contact between the wheels and the rails; he had heard of flashes being seen between the wheels and the rails. That was due to the wheel hopping on the rail, and certainly produced a disturbance in the telephone. Anything like dirt or a stone on the rail which made the wheel jump, or if the wheel did not press uniformly on the rail, would cause a disturbance. The contacts in the exciting dynamo, and the contacts between the brushes and the commutator strips in the motors on the cars, also contributed to the disturbance. It was not necessary, in order to work tramways successfully by electricity, that a system of single insulated wire overhead should be used. There had been many tramways constructed on this system in America, but we knew of none in Europe, except that at Leeds. The Buda Pesth system involved no other separate rail being laid except the two rails on which the tramway ran. The conductor was underneath one of the rails, the rail serving as a guide to the blade which made the contact with the conductors in the troughs. An aperture in the rail was necessary, but it might be a smaller aperture than that required for a cable tramway system. The effect of friction upon the insulation of the connection between the motor in the car and conductor in the trough might be easily provided for by using pieces of solid insulating materials, which might be very thin, placed on the two sides where they might come into contact with the sides of the trench. These could be renewed at practically no expense, as often as might be necessary, once a day, once a week, or once a month. The width of the aperture in a properly-constructed electric tramway could be reduced to half the width of the template shown of the Buda Pesth aperture; three-quarters of an inch would be a sufficient width. Such a system as the Buda Pesth would offer no more obstruction in the road than any other system of tramway, especially if the aperture were narrowed. There would be no practical difficulty in constructing a tramway in Leeds on that system; nor did he see any difficulty in applying the Vevey system of double overhead conductors to such crossings as it had been suggested there might be in Leeds.

Sir RICHARD WEBSTER: A question was put yesterday as to whether or not the disturbances in the telephones could not be got rid of by duplicating the wire affected for a limited portion only of the circuit, and then going to earth. In your opinion would that cure the disturbance?—I believe the disturbance might be cured for a particular subscriber by duplicating his wire and keeping his system wholly insulated, but that would be exceedingly inconvenient.

Short of that, I wanted to call your attention to the limited alteration suggested of duplicating only a small portion of the way, and then only partially, and having earth return at the central station or to another subscriber. Would that get over the difficulty?—I believe it would not. I have reason for this view in the fact that duplicated wires, perfectly insulated wires, do get over the difficulty of ordinary induction disturbances, but when one point is put to earth the disturbances are immediately heard. Since the Court rose yesterday I have tried that. I have long known that that was the case from information given to me, but I wished to prove it by hearing it myself, and I went to the central station of the National Telephone Company in Oxford Court, and several cases were shown to me, taken according to what lines we could find free at the time, and in each case the most marked disturbance was produced by touching the previously insulated metallic circuit with a wire leading to a gas pipe, or leading to the ordinary earth of the station.

I understand you to say that if the suggestion were made that there should be what I should call a local doubling for either the whole or a bit of a particular subscriber's line, when that came to be coupled up at the central station with another circuit which was taken to

earth, at the central station the disturbance would arise just as much?—Yes.

Mr. JUSTICE KEKEWICH: Might arise?—It certainly does arise in the cases that are known; in many cases that are known, and, I believe, in every case that has been tried.

Sir RICHARD WEBSTER: And practically nothing but an absolute and complete establishment of the telephone system throughout on the double wire with no earths would have the effect of curing it?—So far as evidence from observation goes, that is the case.

WITNESS, in reply to further questions, said he had considerable personal experience of the Glasgow telephonic system, which he had used for many years. That was entirely on the single-wire system, except the communication between Largs and Glasgow, and some of the communications between the exchanges. The system worked admirably—with difficulties; but the difficulties were none of them, except in comparatively rare instances, due to the single-wire system.

Sir RICHARD WEBSTER: Have you ever anything like the disturbances you heard at Leeds?—A few times I have heard something like it, but not nearly so bad. That was due to the electric lighting of a train between Queen Street and Charing Cross. The electric lighting line runs through a tunnel. The telephone wires are all outside the tunnel, and some of them in houses over the tunnel, and some of them at a distance. The line which comes to Hillhead Exchange, from which I am supplied, lies at a considerable distance from the tunnel, but there are other wires on the same switchboard in the exchange which are much nearer, but none of them, I believe, inside the tunnel, and they are affected.

Is it a fact that the electric lighting wires are not allowed to be taken to earth?—Yes. None of them under the insurance rules, and perhaps not under the Board of Trade.

Cross-examined by Mr. BOUSFIELD: Can you tell us how that is got over in the case you have just put?—Nothing has been done. I hear the disturbance very rarely now. I have enquired, and find the customers have ceased to complain. It has not been found to be very frequent. I think there must be some causes which make it aggravated at certain times; but, as a fact, it is not much complained of now, and efforts are not being made to do away with it.

I rather gather from you that you doubted whether the mode I suggested to Dr. Hopkinson to take a subscriber to earth near the exchange, instead of at his own place, would cure the disturbance?—I doubted at the time from information I had had, or from my general knowledge of the working of the National Telephone Company's system. I went to Oxford Court for the purpose of having it made to my mind not a matter of doubt, or to get the truth, to hear for myself.

I believe you can see as far into an electrical problem as any man living. You have seen into a good many, have you not?—No, I am afraid not. I have not seen through any yet.

I want to put this case to you. Here is a tramline, and here is the exchange, a mile or two from the tramline, as I believe it is at Leeds. Here is a subscriber, whose wire, for some distance, runs parallel with the tramline, and is taken to earth near the subscriber's house. What I suggest is that instead of taking him to earth at his house, you should bring back a return wire and take it to earth near the exchange.—Yes; that is a very good suggestion. I do not think that would cure the disturbance, from what I heard with my own ears last night.

I am going to ask you why. At all events, so far as those wires are properly doubled and twisted round one another in that part of the double circuit, the inductive effect will be neutralised, will it not?—The inductive effect will tend to produce a current in the same direction in the two wires. That would produce static electrification.

That electrostatic effect is an effect that you always get even with a single wire, is it not?—Yes.

There would be no difference of any kind?—Yes, because when there is earth at the subscriber's, the effect would be to send a current through the single insulated wire, and back through the earth. When the subscriber's line is insulated as you propose, the tendency would be to send a current in the same direction in the two parts, in the outgoing and incoming wire.

They would neutralise one another, would they not?—The inductive effect would tend to produce a current in the same direction in those two wires, an alternating effect of great rapidity,

The current would be neutralised, but there would be an electrostatic effect left?—With that electrostatic effect there would be a regularly alternating current in each wire.

Now the effect that you have spoken of would be precisely the same, would it not, in a proper metallic circuit, without its going to earth?—It would be vastly less, because of the circuit being completely insulated, and there being nothing but the capacity of the insulated system.

I did not gather quite that. You gave a direct answer to my question. The electrostatic effect which you have now spoken of would be identical in a closed metallic circuit, would it not, with what you have described?—In a closed metallic circuit, insulated, it would not be identical; it would be very much less.

Why?—Because when one end is put to earth the earth is drawn upon for as much electricity as is required to electrify half the line or the whole line, if need be. I heard that electrostatic effect upon four different circuits last night. Those circuits were between London and Birmingham, two different lines between Sydenham and London, and between Regent Street and Oxford Court.

When you are dealing with a long distance, such as from London to Birmingham, that electrostatic effect has been for some time a recognised thing, has it not, among engineers?—Yes.

But when you are dealing with a comparatively short length of line, such as these lines which we are discussing in Leeds, have you any evidence that the electrostatic effect of which you have spoken would take place?—I am a witness to facts. I am perfectly willing, if my lord wishes me, to express my own opinion, but I wish rather to give evidence as to what I heard, than as to the scientific explanation of it.

Mr. JUSTICE KEKEWICH: If they are relevant, I believe we shall all wish to hear, not only the facts, but your explanation of them.

Mr. BOUSFIELD: I am asking, really, as to the theory of the matter. I gather that you suggest that upon a short line there would be an electrostatic effect of the kind you mention which would interfere?—Yes, I suggest that, and I see at present no other explanation of it.

If I am right, as regards a short length, that theory has not yet received the stamp of general approval?—I do not know that there has been much enquiry into the subject. It must be remembered that the disturbance here being of exceedingly short duration, the disturbances which prevent clearness of speech and the fluctuations that give articulating currents are of very high frequency, and neither calculations nor experiments have as yet gone very far with reference to the electrostatic effect which will influence such tests, whether they are articulating currents or disturbing currents.

Is it not a fact that that method of earthing that has been suggested to you must be better than having the two earth's at opposite ends?—I believe earthing it at the home station will diminish the disturbance; it would certainly not abolish it.

Do you think it would leave any disturbance that would be of practical consequence in the working of the telephone?—As far as I am able to judge, I think it would.

And you judge from two or three circuits that last night you took to earth, or touched with the gas pipes, in the exchange in London?—What I heard, for instance, between London and Sydenham. I think that is a closely analogous case, and it certainly demonstrated that the double wire system was not a protector against the disturbance that we know most of unless it is all insulated.

Of the conditions of that line between Sydenham and London you of course could know nothing?—Of course my information can be corrected if it is not accurate; but I believe it is. There are two wires on posts between London and Sydenham. Those wires were arranged in a cross-over system, the usual system for completing the wire circuit to obviate disturbance.

As to what the different disturbances on the route might be, and as to what disturbing element might be introduced into the system when you took the insulated circuit to earth, you made no investigation?—No. I understand that there were many other wires in the neighbourhood, and I believe other wires on the same poles.

You, as a scientific man, would scarcely consider that an experiment of that kind, with the conditions of which, outside the office, you knew nothing, was sufficient to base a theory on, would you?—It would be an auxiliary towards a theory, certainly. It suggests that we have no demonstration whatever that the protection against the telephone disturbance would be practically sufficient if one point of the complete circuit is put to earth.

The disturbance that you heard of course may have been due to conduction, or to some other cause?—Conduction and induction. If there were imperfect insulation there would be something of conduction.

The disturbance that you heard may have been due to conduction?—Yes, it may have been partially due to conduction.

Then the result is, as regards induction there might have been a cure, but as regards conduction, none?—Certainly, due to conduction through the earth wire; there is no doubt of that.

I mean by leaky circuits. One of the insulators may have been leaky and your wire to earth may have been made a complete circuit, and sent a wholly foreign return through the circuit?—Yes; but we have the fact that it was quite satisfactory, almost absolutely silent, when it was left insulated. Immediately it was touched the sound arose. I did not test the line for insulation, but it is not merely the one case I experienced, it was the universal case; every pair of wires like that experimented on in the same way shows the same result. I cannot say that there was absolutely perfect insulation on each of the pairs of wires that I tried yesterday evening, but I have reason to believe that the insulation was practically perfect.

Have not the facts which have led you to this opinion been really drawn from experiments on long distance wires?—No, not from long distance wires, but from wires of a few miles length. In fact, if I remember rightly, it was before the wire to Birmingham was laid at all that this effect was first noticed. There were many efforts to cure the disturbance. It was supposed that a metallic circuit with one point insulated would cure the disturbance. Practically it was ascertained it does not. You have it always in every case.

Your suggestion is that in order to cure the disturbance the metallic return must not go to earth, but must be a complete return?—Must be insulated everywhere.

And that would be a perfect cure?—Perfect is a very large word. To the best of my belief it would be a practically perfect cure. A twig of a tree touching the wire would at once introduce a loud disturbance.

It would give you a vastly better telephonic communication than you now enjoy with earth wires?—No, not than we have enjoyed, because we have enjoyed very satisfactory communications with earth wires.

Your experience in Glasgow has been that the disturbance of the telephones has been very small?—Very small; practically it does not disturb us at all. What disturbances we have had have been mainly due to little faults in the instrument, or sometimes to imperfect insulation. I have been sometimes troubled with the sound being too faint at Largs, but then there are a number of different ways of getting from Largs to Glasgow, and two or three different wires may be put on, and sometimes they put me on to a bad wire; but whether between Largs and my house in Glasgow, or between my house in Glasgow and the laboratory in Glasgow, or any other customer in Glasgow, practically, the noises and cross-talk do not disturb us at all.

Your experience of electric tramways is limited?—Yes. I am one of the directors of the Giant's Causeway Tramway. There, there is an iron rail put down by the side of the road. The return is by the rails on which the cars run. There have been some complaints that one or two horses have met with their deaths by falling and lying against the iron rail. But people touch the iron rail quite freely. Country people come to get cured of rheumatism by touching the rails; I do not think there is any case of a human being having been hurt by it at all.

Where you have switches on the tramway line and crossings, and so on, they are a great deal easier to manage, and simpler with a single conductor than with a double conductor?—Only simpler, as one is simpler than two. All the appliances that serve for the one would serve equally for the two, only they must be duplicated. There is no difficulty whatever in doing it, not the slightest difficulty in crossings, or anything else. What can be done with the single conductor can be done with the two conductors, without any additional complication.

You are speaking without any practical acquaintance with this subject at all?—No, I am not. I am speaking from practical acquaintance with all that is required for one conductor on several different lines. I know the Bessbrook line in Ireland also, and the Leeds line itself I have practical acquaintance with enough to allow me to feel absolute confidence that there will be no difficulty in carrying out what you have described.

In the model produced there is a single wire insulated with a break at a certain point where it has to be crossed. The line is made continuous by means of hand brasses. There is a break in the line of some 2 feet. In that case, the fishing rod and trolley would be out of contact with the circuit for some distance?—Yes.

Now, when you have to apply a double system of conductors to a place like this, which represents the end of Boar Lane, you have a number of positive wires crossing a number of negative wires, and they ought to cross at the same level as nearly as may be?—Where the trolleys leave them they must be at the same level. But there is nothing of this sort on the electric line at Leeds.

Would not such a system as this, with the necessary breaks in it, be impracticable for application in a place like that?—No; I think it not at all impracticable.

In a crowded thoroughfare where there are a number of streets meeting, the tram would very often have to pull up in order to allow other persons or vehicles to pass. It might, therefore, have to pull up in the centre here?—No, because they would always have the trolley doubled, as in the Portrush line; the brush or trolley would be doubled so that the one end of the contact would be on and the other off. There would be no point where it would get no current.

You suggest that there should be two trolleys and two fishing rods, as it were, taking current at the same time?—Under no circumstances would I allow the circuit to be broken except by the conductor. It would be very bad engineering to allow a trolley to break the circuit and make a great flash, destroying probably some of the electro-magnets. The breaking of a current must be done by the conductor, the trolleys must bridge over every gap, so that there will be no break of circuit.

Do you know of any case where what you suggest is actually done in practice?—At Giant's Causeway. There there are two brushes and gaps large enough for a cart to pass through. The current is never broken.

What would you suggest as the distance between the brushes?—If I designed the thing I would endeavour to find out what was the most convenient in a general way. I should like to have one at one end of the car and the other at the other. Possibly I might make them a good deal nearer and make a duplication.

Whatever the distance between them, there is still the risk that one set of brushes might be on one break and another set of brushes on another break, so that even then the car might stop at the place?—I think that would be impossible, because these brushes are all at frequent distances. You lay it down on an accurate drawing and you would see how many inches or feet you have, and you take care that one will be on before the other.

You know a good many accidents have happened to telephone wires from their being weighted with snow. When you double your network, you double the liability to a breakdown owing to accumulations of snow?—Yes, if you have every wire to every customer doubled.

And with regard to trams also, when you double the network at a place like this in the model, you also increase very largely the liability?—No, I do not think snow will get a chance of lodging in the wires on the tramcar system. There is a trolley or brush running along the tramcar system, and none along the telephone system.

Having regard to the closeness of this network, does it not appear as if snow might easily bridge over some of these places, and make connection between the positive and negative?—A good many pieces of snow might lodge, but it could not make any disturbance of any appreciable character.

There is very considerable difficulty, is there not, in maintaining these curves properly with the two overhead conductors, where you have to follow the curves of the tramlines?—I think tramway engineers are quite competent to deal with such a difficulty.

Replying to questions on the Buda-Pesth system, Lord KELVIN said he had no doubt the slot in the rail might be reduced to less than three-fourths of an inch, and that an electric system required a smaller aperture than a cable system. It would be possible, in the latter case, to have the hanger several inches broad along the length of the slot, and very narrow, transversely to the slot, so as to get the necessary solidity, in order to transfer the mechanical forces. Mud and dirt were constantly falling into the slot, but the system, to a large extent, would clean itself out, the accumulators running out at the proper place; but there was nothing easier than to sweep it out. Anyone could invent a brush that would serve the purpose in half a minute. He would suggest a brush that would go through and slew round into position to begin brushings. It was necessary to keep the hanger from contact with the sides of the slot, but there need be no clearance. He would have insulating pieces that would be allowed to rub on either side of the slot. It was wonderful how slow the rubbing down of such a substance as vulcanite might be; but if necessary, the thing could be repaired every run. Lignum vitæ, too, was a thing that wore marvellously little under heavy pressure and at great speed. With regard to the Leeds line, he attributed some influence in the disturbance to the connection between the trolley and the overhead conductor, and between the wheels of the rails being many and variable. The trolley was kept pressed against the wire by a spring in the fishing-rod connection. Where all four wheels were connected with the motor, if one wheel were lifted off the line by a stone, there would still be three wheels left to maintain the connection. He had heard of flashes being seen from wheels of tramcars in America; but perhaps the whole four were not connected in that case. He knew of no double conductor tramway lines in existence except those at Buda-Pesth and Vevey. In America there was a large number of applications of electricity for tramway purposes, but he had heard great complaints from private persons who had had experience there, who seemed not to consider the present state of affairs final at all.

Mr. BOUSFIELD: There has been in America perhaps twenty times the experience accumulated on the subject that we have here?—Yes, I should think there has.

And you probably know that among other systems the double conductor system in various forms has been tried and has been afterwards abandoned for the single conductor system?—I have heard it stated that that has been done in some cases.

You have said that all telephones in this country were worked with the earth return—that that is the generally adopted system?—Yes. I only know of Newcastle with the metallic circuits. All the world has heard what the New Telephone Company intended. I have heard they have to some degree in Manchester carried out the insulated metallic system. Then quite recently some of the lines of the National Telephone Company have been duplicated on an insulated system; those, for instance, going out to considerable distances, such as to Sydenham. Then to Regent Street there were twin wires insulated in a lead tube.

The plaintiff's system with trifling exceptions is the only one that has ever been worked in this country, is it not?—The only one that has been worked in this country at all.

Therefore the plaintiffs are the only people practically at work in this country?—Yes, I believe so.

But the New Telephone Company have started an exchange at Manchester, and adopted the metallic return system as the best and the most reliable one?—They proposed to adopt it as the best and most reliable one. They have now joined the National Telephone Company, so that is all one.

I hear they have amalgamated now, but they did erect an exchange in Manchester, did they not?—I believe so, but I had no information regarding it, nor of their experience in that exchange, nor of the expensiveness of that system as compared with the system generally followed by the National Telephone Company.

Is it not the fact that in the case of Stockholm the government there have insisted everywhere on metallic returns?—I did not know that the government had insisted on it, but I presume if so, it was from some special reason of the government, and not chosen by the company as the best system.

It is a fact, is it not, that although the earth system is possibly a little cheaper, yet that the metallic return system gives better results, and is now the only system which is not liable to disturbance from extraneous causes?—It is liable to disturbance, although the disturbance is much diminished, but I would not say it was necessarily the better system. I should say the single wire with earth returns is the better system when the circumstances allow it.

Re-examined by Mr. MOULTON: You have been asked about an experiment in which there was a long piece of wire fastened to the overhead conductor, and also fastened to the line, and the car was moved. That would leave the disturbance that arose from a commutator unchanged, would it not?—Yes.

Would that disturbance be observed if they had the double metallic insulated return?—Yes.

So far as the slot in an electric tramway with double metallic insulated returns is concerned, is it necessary that the hanger should be rigid? Is rigidity necessary for transmitting the electricity to the motors?—Certainly not.

But in the case of the cable tramway is it necessary?—I suppose it is. I do not know exactly. I daresay there would be something flexible above, also.

It has, at all events, to transfer mechanical strain?—It has to transmit a large amount of mechanical force.

Speaking as a mechanician, which is the simpler problem, the electrical arrangement or the cable arrangement?—The electrical is vastly the simpler problem.

You have been asked some questions about the imperfect contact with rails. If sparking is seen at the rail, does that show serious interruption or not?—It shows serious interruption, and probably of a kind that would produce a disturbance on the telephone wires.

WITNESS, in continuation, said he was a director of the Portrush Company. That line ran through country, and there were no telephones near it. There were telegraph wires, but he had never heard of their being disturbed. The telegraph was not very easily disturbed by such currents and variations of currents as would disturb the telephone. The Portrush railway was never interrupted by storms or anything of that kind. The only way he had ever heard of it being disturbed was by the traffic being too heavy, and the electric power not being sufficient for the traffic.

Mr. MOULTON: Your experiment last night was made by con-

necting the circuit to earth and then taking off that connection?—Yes.

What was the difference in the results?—All was silent when I first put the telephone to my ear; then I spoke through to Birmingham to make sure that that was the line I heard on. Then I stopped speaking and listened, and found perfect silence. Then the wire was put on one side of the telephone between the terminal of my telephone and the line wire. There was a loud disturbance. Then the wire was shifted to the other side, and there was a loud disturbance. I heard the phonophore quite distinctly. The phonophore is on the line from London to Leicester; ten miles of the single phonophore line, which is a single insulated wire and earth return, is beside the telephone line to Birmingham. Of those ten miles for about eight the phonophore wire is within very few feet, 20 feet I should say, of the telephone wire. There was no mistaking that it was the phonophore, because I heard the musical note, and the transmission of the musical note which gives the signals, according to the Morse alphabet, on the phonophore.

In your opinion would that occur to a greater or less degree if the remedy suggested by my learned friend was applied, namely, the bringing back a wire and earthing it at a distance?—The putting it to earth would produce the disturbances, and not merely on a long line like that from London to Birmingham, but on shorter lines, from London to Sydenham.

With regard to the train at Glasgow, which caused trouble to the telephones, was that one which carried storage batteries or was electricity supplied to it from outside?—Electricity was supplied to it from outside through the iron rail between the two rails that carried the carriage; the return was through the wheels on which the carriage rested.

(To be continued.)

WOODHOUSE & RAWSON UNITED, LIMITED, AND ITS PROMOTIONS.

Is it Fate or Chance or only Circumstance that has ordained that at the present time attention should be prominently drawn to the affairs of Woodhouse and Rawson United, Limited, and to two of their creations—the International Okonite Company and the Foreign and Colonial Elmore Company. We think it may be ascribed to Circumstance—the circumstance that in each case the evil day for disclosing uncomfortable facts has been deferred as long as possible, and as the report of each company cannot be delayed any longer, they come all at once and intensify the unsatisfactory condition of the whole group.

WOODHOUSE AND RAWSON.

The report of Woodhouse and Rawson is really distressing reading, so much so, as to lead one to suppose that the directors are taking the shareholders very fully into their confidence, and—in general parlance—making a clean breast of the position, except that in some instances attempts are made to take off the rough edges of uncomfortable statements, and to raise hopes which should not be raised. The reference to the manufacture of incandescent lamps having ceased during the past year we do not understand, as we were under the impression that the manufacture ceased some years ago in obedience to the decision of the Law Courts. No doubt Woodhouse and Rawson, with their established plant, will be in a position to compete on the expiry of the patents, but except for their previous experience, they will be in the same position as everybody else at that time. But it is a department of legitimate manufacture, and such as attention should be turned to, although incandescent lamps at free trade prices will not avail much for dividends on the overloaded capital of the company. It is the overloaded capital which is so observable on an inspection of the accounts. There is a share capital of £427,000, and a debenture capital of £164,000.

The assets in premises, plant, furniture, and cash are £90,666, in stock, £123,119, a balance of debtors over creditors of £14,288, making a total in these tangible items of £228,073. The remaining items are "moiety special expenditure on advertising," £5,669: patents, £73,450; goodwill, £99,263; and sundry investments, £101,847. Reserving some remarks on the investments these may be called the intangible items, and they total to £280,229. The tangible and intangible together amount to £508,302, whilst the share and debenture capital together amount to £591,000, and there is a further liability of some £4,000, making a balance on the wrong side of some £86,700.

The fact that the lamp stock has been written down 75 per cent. because the price of lamps on the continent is a quarter that of England, reveals that such stock was upheld at too high a price last year. The Swan United valued their lamps this year at 8d., while last year they valued them at 9d. Although W. & R., anticipating a sale in England, may have considered it fair to put a greater value on the lamps than they would have done had they had no hope of an English market, it looks as if they had put on too much as profit in their valuation. There is nothing to show what they were valued at last year, or this; but if we take the Swan figure of 8d. for this year that would put last year's valuation at 2s. 8d. each.

The state of affairs has been discussed by the financial papers with remarks of a more or less caustic nature, and the loss on the one year's working has been especially noticed. But is the amount an actual loss on the year's working, or does it arise from Circumstance, which has again compelled the facing of facts which have in previous years been regarded in too sanguine a light, and have accumulated, with the result that they now look a great deal worse than they would have looked if they had been taken in instalments? The shareholders can now, at least, realise the situation and estimate for themselves what the prospect is. It is unreasonable to suppose that a company with £2,000 in the bank and a mortgage on its freehold property would continue to hold £100,000 in sundry investments if they were readily saleable, and there is no doubt whatever that the real value of this item is a most material matter.

Again it is useless for the shareholders to suppose that the reputation of their company in the industrial department is entirely independent of the reputation it has earned, or may eventually earn, in its promoting department, and this has some bearing on the valuation both of goodwill and patents, neither of which would seem to be under-estimated, seeing the comparatively small returns from the industrial business.

Deducting the sum of £26,012 10s. depreciations on investments, which we may take to be the year's loss of that part of the business which deals with public company work, there remains the sum of £103,752 1s. 5d. as the apparent loss for the year on manufacturing, supplying, and contracting.

We propose to point out what appears to be the position of the company from the point of view of an ordinary manufacturing and contracting concern, so far as the meagre information given by the directors enables it to be done. The directors state that the turn-over of the year has been £151,121, and upon this turnover a loss of £103,752 1s. 5d. has been made; in other words, for every £1 worth of goods sold, about £1 13s. 6d. has been expended, directly and indirectly, leading to a loss amounting, on an average, to £2,000 per week. It is difficult to see how it is that the company have avoided closing the doors, for since the date of these accounts 20 weeks have elapsed, and at the same rate of loss, £40,000 more capital must have disappeared, and as the cash balance at this date stood at £2,033 16d. 8d., it would appear that considerable realisations or mortgagings of stock, or investments, must have taken place. To what can be attributed this extraordinary and unparalleled state of affairs? Is it a fact that the market prices of electrical commodities is such that the average cost of production is 68 per cent. above the selling price? The returns of other companies, even the least profitable, negative this idea. One alternative remains; the directors appear not to understand the business they direct. However they may understand the public palate for investments, they clearly are quite out of their depths in electrical manufacturing and contracting. It is palpable on the face of it, that a concern which turns over its paid up capital once in about four years; which allows an average of six months' credit to its customers; whose stock, finished and unfinished, is nearly equal to its annual turnover; which has changed its general manager once or twice in twelve months; which has united the factory managements in London and Manchester to economise, only to find it was "most unsatisfactory;" which has worried its customers almost to distraction by the complication of its accounts, between Woodhouse & Rawson (in liquidation), Woodhouse & Rawson, Manchester; Woodhouse & Rawson, Cadby Hall; Woodhouse & Rawson, Kidsgrove, &c., and yet always Woodhouse & Rawson United, Limited; is very much mismanaged. And what else can be expected? Can any member of the board be pointed out who has had the training or the experience necessary to manage or to choose managers for a business embodying every detail of me-

chanical and electrical engineering? The board are at the mercy of the staff, and, at the shareholders' expense, are trying to discover by experiment how to manage a business so complicated, that it would be almost difficult to pick a board who could properly control it. The shareholders intentions will be seen from our report of the meeting; without further capital it is obvious the business cannot continue; with it it will be useless to continue unless the shareholders make up their minds to have managers who understand electrical engineering and manufacturing, and are prepared to pay them to devote their time to the work. We say that the works at Kidsgrove, at Manchester, at Cadby Hall, at Chiswick, with branches at Johannesburg, Sydney, &c., cannot be properly directed for £2,000 per annum by directors who really know what they are doing, and the sooner the shareholders realise this the sooner will the loss of £2,000 per week cease. The fact is, the business is in one vast muddle, arising primarily from the fact that it has never been definitely settled whether the company is a trading company or not; if it is, let the shareholders say so, and choose a board who understand trade and manufacture, not company finance.

If the shareholders and directors will but realise the incongruous character of that dual condition to which the report refers as "industrial department" and "financial enterprise," if they will but decide to choose one or the other as we advised them when they commenced the company promoting business, they may yet retrieve something of their position, but to do any good at all they must face every adverse fact and not seek to defer an uncomfortable operation to some later period when it may be too late.

ELMORE'S FOREIGN AND COLONIAL COMPANY.

Elmore's Foreign and Colonial Company is one of the most fortunate of the copper depositing group. Formed only for the purpose of promoting subsidiary companies, it has paid a large dividend from the proceeds. The English Company also did the same, but as it went in for manufacture as well, it has had some drains on its resources which the Foreign Company has escaped. Notwithstanding the comparatively narrow range of the company's operations, the report for 1891 is only just issued, and it does not afford much satisfaction in quarters which have previously been very ready to take a roseate view of Elmore affairs. The *Financial News* of the 19th inst., in concluding a long article on the company's report says :—

"An improvement in value can only come from the commercial success of the process. It was going to do marvellous things, and those connected with the companies still speak as confidently of the invention as ever. But the long delay in showing financial results—the only results investors care about—has made many hearts sick, and not until the huge profits that have been promised really appear in the books, can any substantial improvement in the values of the shares be looked for."

We have not seen *Truth* lately, and cannot, therefore, say whether amongst the faithless it remains faithful still.

INTERNATIONAL OKONITE COMPANY.

The meeting of this company stands adjourned to January 10th, before which date we shall hope to refer again to the prospects before the shareholders.

NOTES.

Newbury Lighting.—The Town Council are seeking powers to borrow £10,000 for gas extensions. A local government enquiry was held on Saturday.

Ealing Electric Lighting.—The Local Board last week decided to instruct Messrs. Bramwell & Harris to prepare a report upon an electric lighting scheme.

Lectures.—A lecture on "Electric Lighting of Large Buildings" was delivered before the Edinburgh Architectural Association, last week, by T. Crichton Fulton.

Reading Electric Lighting.— Mr. Preece's recommendations and his reply to the Corporation as to terms, has been referred to the Electric Lighting Committee for them to report upon. It is proposed to apply for powers to borrow £15,000, which would allow for 50 to 100 arc lights for the streets, and 4,500 private lights.

Hampstead Electric Lighting.—The Vestry have themselves decided to undertake the supply of electricity, and to erect a central station, and to confer with Mr. W. H. Preece as to terms for preparing plans, &c.

Yarmouth Electric Lighting.—It seems highly improbable that the feeling which exists against the electric lighting scheme at Yarmouth will be anything like strong enough to change the opinion of the council.

Fleetwood Electric Lighting.—The Fleetwood Improvement Commissioners have appointed Mr. T. L. Miller, of Liverpool, electrical engineer, to advise them upon various electric lighting tenders.

Paisley Electric Lighting.—The authorities are applying for an extension of time for their electric lighting provisional order. Tenders have been received for taking over and carrying out the powers for that order.

Edinburgh Electric Lighting.—A Committee of the Town Council has been appointed to visit other towns for the purpose of obtaining information regarding electric lighting.

Electrocution.—Another murderer was executed by electricity on December 19th, at Sing Sing prison, New York. The execution is pronounced to have been the most successful by this method that has hitherto taken place. The victim undoubtedly became instantly unconscious at the first contact, and died after 18 seconds, although as a measure of precaution a second contact was made.

The Sector of the Champs Elysées, Paris.—At one of the last sittings of the Municipal Council several councillors, remarking that the electric lighting works had not yet been commenced, although permission to do so was granted two years ago, demanded the reason of this delay. The manager of the works replied that the making of the sheathed concentric cables enclosed in lead required a long time. This manufacture has been established at the Cail works. They can now make a kilometre a week, and have been working since November 6th, and will continue regularly.

Windsor and the Electric Light.—The Windsor and Eton Electric Light Company, which has just laid down its mains at Windsor, was summoned on Monday last before the borough magistrates, for breaking up the streets without the permission of the Town Council, which had been refused in consequence of the company having failed to satisfy the Board of Trade that it was able to fulfil the duties and obligations conferred upon it by the provisional order. Mr. J. H. Long, the town clerk, prosecuted.—The bench took a lenient view of the matter, and inflicted a fine of £2 and another of £9 16s., the latter sum representing ½d. a foot for the area of pavement disturbed. The company also had to pay the costs of the proceedings.

Cost of Gas and Electricity in the City.—At the Court of Common Council on Thursday last week, on a recommendation by the General Purposes Committee to the effect that £607 17s. 11d. should be paid to the City of London Electric Light Company for lighting the Mansion House for three quarters to September 29th, Mr. Morton asked whether this was the total cost, and, if so, what was the difference between the cost of electricity and gas? It was stated in reply that the actual amount in excess of the cost of gas was £336; but a great saving would be effected in the matter of renovating decorations.

St. Austell Electric Lighting.—The St. Austell Electric Lighting Provisional Order expired on the 1st inst., and Mr. J. E. Veale, the undertaker under the license, intends applying for a renewal.

Hospital Electric Lighting.—The Duke of York, opening the South London Ophthalmic Hospital on 15th inst., completed an electrical circuit, automatically opening the hospital and illuminating the hall.

Dublin Tramway Extension.—The Blackrock Township Commissioners intend holding a special meeting to consider whether they will petition Parliament in favour of the Dublin Southern Districts Tramway Bill. This is a bill to authorise the Dublin Southern District Tramway Company to construct, lay down, divert, or double their tram lines, and to introduce electricity as a motive power.

Our Foreign Contemporaries.—The New York *Electrical Engineer* states that "Mr. Fred. DeLand, who for some years past has been the Western manager for the W. J. Johnston Company, Limited, and the representative of the *Electrical World*, has resigned his position, and will hereafter have no connection whatever with the concern. Mr. DeLand, who is a graceful writer, will become the World's Fair correspondent of the *Scientific American*. His long years of faithful service have won him many friends in technical and industrial circles, and he will now have an excellent opportunity to do good work and derive some benefit from it. Mr. DeLand will also conduct a monthly paper called *World's Fair Electrical Engineering*."

The Exploration of the Atmosphere.—We have often urged that some systematic attempt to obtain information concerning the electrical state of the atmosphere, by means of stationary balloons, would be most desirable, and we are glad to notice that since July those levels into which aeronauts rarely ascend, have been the subject of careful examination near Paris. At a meeting of the Paris Academy of Science on November 21st, Mons. Gustave Hermite laid before the academicians a report upon the observations carried out in this way by a special commission. So far, the only results obtained refer to pressure and temperature, the variations of which were automatically registered. It is to be hoped that the success which has attended this preliminary investigation will encourage the "Commission des Aérostats" to extend their observations to the electrical conditions of the atmosphere at high altitudes.

Proposed Electric Railway between Clapham Junction and Paddington.—The proposed electric railways, which the Joint Select Committee's report dealt with, were confined in their objects to meet the wants of the City and Charing Cross centres, but did nothing to provide for the north and south communications of West London. A scheme is, therefore, now on foot to promote a Bill in Parliament to provide direct and rapid means of transit between Paddington, the terminus of the Great Western Railway, and the great populations therein and north of the same, and South Kensington, Brompton, Chelsea, Battersea, Wandsworth, Clapham, and the districts which already have railway communication with Clapham Junction, the point where the L. & S. W. R. and L. B. & S. C. R. enter London. The proposed line will follow, by means of a deep tunnel, on Mr. Greathead's well known system, a route which lies very nearly due north and south, and will have intermediate stations at or about Uxbridge Road, Kensington Road, Cromwell Road, Old Brompton Road, Fulham Road, King's Road, Cheyne Walk, Battersea Park, Battersea Road, Wandsworth Road, and Clapham Road. It will also have covered means of access to the Great Western, Metropolitan, District, Chatham and Dover, and Brighton Railways; also with the Public Institutions on the Estate of the Royal Commissioners of 1851, and the works will give rise to no disturbance whatever of the surface, or of the subsoil to a considerable depth. This line cuts at right angles all the great east and west railway, tramway, and omnibus routes, in the west of London, and terminates at two of its largest railway centres, with the certain prospect of affording great relief to internal traffic, and of bringing districts, now physically widely separated, within easy reach of one another.

Weston-super-Mare Electric Lighting.—The question has been again postponed.

Newport Electric Lighting.—Prof. H. Robinson is to be consulted regarding the electric lighting.

Electric Block Signalling.—The G.W.R. Company have established their improved electric block system at Menheniot.

Poplar Electric Lighting.—The Poplar Board of Works have decided to apply for a provisional order for the supply of electricity.

Islington Electric Lighting.—The Electric Lighting Committee have decided to visit Bradford, Brighton and Southampton, regarding electric lighting.

Darlaston Electric Tramways.—It has now been definitely decided to commence to run the electric cars on the tramways to Wednesbury, James Bridge, and Walsall on the first Monday in the New Year.

Crystal Palace School of Engineering.—The award of certificates for the winter term took place in the lecture theatre of the school on Saturday last, the chairman for the occasion being Mr. William Henry White, C.E., F.R.S., C.B., Assistant Controller and Director of Naval Construction, Admiralty.

Accident.—An accident happened at the Yorkshire House-to-House Electric Light Company's new works in Whitehall Road, Leeds, on the 15th inst. Two men were hoisting a girder when the rope broke, collapsing the scaffolding on which they stood. Both men were conveyed to the hospital, one being discharged after being attended to, but the other was received as an in-patient.

Bedford Electric Lighting.—At a recent meeting, the Town Council decided to employ an electrical expert to advise them. It was said, however, at a meeting held last week, that the resolution was not legally carried, and it has now been resolved to call a special meeting to consider the whole question. The chairman, and several members of the Lighting Committee, have resigned.

Kingswood Electric Lighting.—Several ratepayers have applied for extensions of the electric light to their particular neighbourhoods, but the Local Board have said that they are not prepared to extend the lighting area until the existing lighting proves more satisfactory. A resolution was passed expressing surprise at the supplying of electric light to private parties in the present condition of the installation.

Edison Patents.—The United States Circuit Court of Appeals, Second Circuit, have been hearing arguments in the appeal for an injunction by the Edison Electric Light Company against the Sawyer-Mann Manufacturing Company to prevent the latter from manufacturing incandescent lamps, to which the Edison Company claims sole patent rights. The decision come to will prevent Westinghouse making, using, or vending incandescent lamps under the Edison patent.

Electric Light at Sutton.—A lecture was delivered on Friday evening last by Mr. Ed. C. de Segundo before members of the Local Board and the principal residents of the district. Gauging with more accuracy than lecturers usually do, the points on which the audience required information, Mr. de Segundo said little or nothing about the nature of electricity as a physical force, but gave some hard facts of what electric lighting would cost, the advantages, and so forth. Figures were given showing the cost of various central stations in England, also what an installation might be expected to cost in Sutton. Some really valuable information was given; we have, indeed, perused experts' reports to local authorities which contained less. The lecture was illustrated by lantern slides, showing the interiors of central stations. An interesting discussion followed.

Sunderland Electric Lighting.—An expert is to be engaged to advise regarding electric lighting. Not more than £250 is to be expended for obtaining advice.

Redruth and Electric Lighting.—A meeting of the promoters of the Redruth Electric Lighting Company was held last week, when half the necessary capital was subscribed.

Taunton Electric Lighting.—A Board of Trade inquiry was held last Friday at Taunton, regarding the application to borrow money for electric lighting purposes.

Chicago Exhibition.—The Royal Commission for the Chicago Exhibition are arranging for a series of introductions to the different sections of the Catalogue of the British Section. Amongst those who have promised to contribute articles is Mr. W. H. Preece, on "Electricity."

The City of Paris and the Telephone Service.—A dispute has just arisen between the city of Paris Council and the Telephone Company with regard to a sum of money. The telephonic circuits are all laid down in Paris in the sewers. Now the telephone service belongs to the State. The City of Paris intends to claim this year from the State a sum of 73,700 francs for the laying of subsoils, and a conflict is now raging on the subject. The State refuses to pay, saying that the lines are now of public utility. The official charged to draw up the budget for the City of Paris, is however, of opinion that this sum should be carried to the receipts.

Old Students Association.—The report for the 1891 to 1892 session is issued, and states that the Association now numbers 200, consisting of 7 honorary members, and 193 members and associates. During the Session 56 members and 8 associates have been elected, many of them being well known in their respective professions. During the same period 8 members have resigned, and 30 have been struck off the list for non-payment of subscriptions. During the Session some changes have occurred on the committee, Mr. A. E. Ruddock having replaced Mr. Lamb, who resigned on leaving London; and Mr. Vignoles having taken the posts of hon. secretary and hon. treasurer, in succession to Messrs. R. J. Wallis-Jones and Duncan Pearce.

Paris Society of Electricians.—On December 7th, the monthly meeting of the Society of Electricians was held. M. Vlasto was to have held a conference on the laying of the submarine cable from Marseilles to Oran, last August. But he really gave no technical explanation, merely contenting himself with showing photographs representing the vessel, *François Arago* on the coast or in the open sea during the laying of the cable. Nothing new was learnt respecting it. M. de Bovet then spoke of the magnetic adherence apparatus employed by the Seine Towing Boats Company. By means of very ingenious arrangements, the inventor has succeeded in keeping the chains of the boats together by suitable magnetisation. He has thus been able to effect considerable saving of expense.

Woodhouse and Rawson.—In another column will be found a report of the meeting of shareholders of Woodhouse and Rawson United, Limited, held yesterday. We fear the shareholders have not realised the situation and resolutely faced the adverse facts. The formation of a "consultative" committee was a wise measure, and perhaps this committee's investigations may lead to the placing of the shareholders' property on a more satisfactory footing. The speech of one of its members (Dr. Squires) would lead us to expect such a result.

Nantwich Electric Lighting.—A provisional order is to be applied for.

CONTRACTS OPEN AND CLOSED.

OPEN.

Leicester.—January 5th for the erection of dynamo house, &c., for the Corporation. Particulars from E. G. Mawbey, C.E., Town Hall, Leicester.

CLOSED.

Blackpool.—The contract for the electric lighting work at the new police station buildings has been placed with Mr. S. H. Heywood, of 12, Brazennose Street, Manchester.

Claybury Asylum.—The County Council have accepted the tender of Messrs. Appleton, Burbey & Williamson, of Queen Victoria Street, at £5,074, for the electric lighting of Claybury Asylum.

BUSINESS NOTICES, &c.

Poole & White, Limited.—Under the winding up of this company the usual summary was issued in the Court of Bankruptcy by the official receiver. The company was registered in February, 1890, and was formed for the purpose of acquiring and carrying on as from January 1st, 1890, a business of electrical engineers, which had been commenced in the previous November, and was then carried on under the style of Poole & White, at 58, Bread Street, City. The business has since been extended, and the company have also recently had premises at King's Road, Camden Town; at 10, Glasshouse Street, London; and at Arcade Chambers, Manchester. The nominal capital of the company was £20,000, and the failure is attributed generally to want of capital. The total liabilities are £23,293, of which £10,104 are unsecured, and there is an estimated surplus of £1,587.

A first meeting of creditors was held yesterday at the Inns of Court Hotel, Lincoln's Inn Fields, W.C., Mr. C. J. Stewart, the official receiver and provisional liquidator presiding. The chairman informed the creditors and shareholders present that he had been given to believe that fully 20s. in the pound would be paid; he also stated that a scheme was premeditated by the directors, but being in ignorance of the scheme himself he called on Mr. Tryon to give some particulars. Mr. Tryon spoke at some length, and, in the end, it was resolved to appoint a liquidator and a committee of investigation, consisting of five gentlemen, with a view of forming a new company out of the old one.

Electric Lighting in the City.—Satisfactory progress continues to be made as regards private lighting. Among the new work recently completed, or in hand, we may mention that the Planet Electrical Engineering Company of Victoria Street, Westminster, are fitting up the premises of Messrs. Johnson and Co., 80, Aldersgate Street.—Contracts have also recently been completed in the offices of the Commercial Cable Company, Royal Exchange; in the premises of the Paris and New York Telephone Company, Royal Exchange; and in the premises of Messrs. T. Knight & Co., Aldermanbury.—The General Electric Power and Traction Company, Limited, of Kentish Town, are at work at 31, Moorgate Street, while Messrs. Rashleigh, Phipps & Company have the contract for wiring the offices in Moorgate Street, of the Star Assurance Company.—Messrs. Grant & Cocks, of Copthall Avenue, have recently completed a contract in the premises of Messrs. Leggatt Brothers, 62, Cheapside.—Electric Lighting work is being carried out at 14 and 15, Poultry, by the Brush Electrical Engineering Company.—Messrs. Smeeton & Page are at work in the premises of the Silverberg Habana Cigar Company, 104, Cheapside.—A contract has also been recently completed in the premises of Mr. H. Littaur, printseller, George Street, Mansion House.

Electric Lighting in the West End.—There are again a large number of new contracts which have been lately completed or taken in hand, among which we may mention that Messrs. Gritchett Brothers, of Soho Square, are putting up fittings at 33, Portland Place.—Contracts have recently been completed in the premises of Mr. W. G. James, 64, Weymouth Street, and in the premises of Messrs. Lilley & Co., High Street, Marylebone. The Electrical Installation Company, Limited, of 64, Victoria Street, are fitting up 42, Wimpole Street.—Electric lighting work has also recently been completed in the premises of Messrs. Mayer and Meltzer, Great Portland Street.—Messrs. Paterson & Cooper are fitting up Baker's Hotel, Baker Street, and also the Victoria Hall, Regent Street.—A contract is being carried out in the premises of Messrs. Tobias Brothers, 8, Oxford Street, by Messrs. E. P. Allam & Co., of Dashwood House, E.C.—Fitting work has recently been completed in the new establishment of Mr. H. E. Randall, 378, Strand, and in the premises of Mr. W. T. Minty, 21, Garrick Street.—Mr. W. G. Cannon, of London Road, Southwark, is putting up fittings at 119, Oxford Street.

The Electrical Wonder.—Under this title a new form of automatic machine is being introduced to public notice, in which is presented a moving picture produced by the rapid flashing before the eye of a series of instantaneous photographs of figures in motion. For instance, one of the pictures presented is that of a lady on horseback, in which the motion of the horse, the graceful swaying of the rider's body, and even the flying of dust at the horse's feet, are all faithfully reproduced. In order to secure this effect, it is necessary to have a series of about 25 photographs, each in succession, being so slightly different from its predecessor, that when flashed across the vision they all form one impression and not a series. The invention would, therefore, probably be more correctly described as a photographic wonder, the electrical part of the arrangement consisting simply of the motor which gives the rapid motion to the series of pictures, and an incandescent lamp in the interior of the machine, both of which are operated as a result of the coin falling in the slot. The camera by which these pictures are taken is the invention of Herr Ottomar Anschütz, of Berlin, and is said to have cost £30,000.

New Switch.—A new and simple switch for electrical purposes has been invented by Mr. Louis Schramm, electrical engineer to the firm of Messrs. Wyand & Sons, of 15, Lower Grosvenor Place, S.W. The mechanism is very simple; the base is so made as to form bearings for handle and guide for a contact shoe, which is free to slide backward and forward, by moving the handle to which it is loosely connected by a bar; underneath the said contact shoe is a V-spring, placed in a channel in the base. The movement of the handle slides the contact shoe over the spring, and as soon as it gets over its centre, the spring being compressed, it causes a quick make and break between the contact lugs fixed on the front part of channel in base. The whole switch is very simple and cheap to construct, being made of porcelain, and no metal parts at back. The cover is also flanged, so that the whole may be let in flush, the flange covering the break of the hole where the base is fixed. We have tried this switch and can speak of it in favourable terms.

The Brush Electric Company.—We take the following paragraph from *Money*:—"We understand that negotiations are pending between the Brush Electrical Engineering Company and the South-Eastern Railway Company concerning the acquisition by the latter of the extensive works of the former in Belvedere Road, Lambeth. If the Brush Company agree to dispose of their works to the railway, which requires them for extension purposes, they will most probably set up their chief establishment at Loughborough, in the Midlands. In view, therefore, of the savings which would be effected on account of labour, fuel, &c., and the compensation which the railway would have to pay, the Brush Company's shares would appear to be an excellent investment just now. The savings by removal would be far greater than is generally supposed, inasmuch as fitters, for example, would receive 31s. 6d. per week instead of 42s. per week in London. The fuel bill might also show a reduction of £600 to £1,000 per annum."

Calendars, Almanacks, &c.—We have received a copy of "Calvert's Mechanic's Almanack and Workshop Companion, for 1893. The book contains much interesting information for those connected with the engineering and general constructive trades. A very nicely got up calendar of 1893 is that of the Western Electric Company of Coleman Street, E.C. Fastened in the front—the cardboard forming a kind of frame—is a photograph of the company's exhibit at the recent Crystal Palace Electrical Exhibition.

Business Alterations.—The large extension in Messrs. W. T. Goolden & Co.'s electric mining and manufacturing business, and the consequent pressure of room in their factory, has led them to arrange for the transfer of their installation and fittings business, as and from January 1st, 1893, to the late manager of these departments, Mr. W. E. Townsend, who will trade under the name of Townsend & McIntyre, at 19, Brook Street, W.

South African and International Exhibition.—The Executive Committee have now made known the result of the juror's investigations. The following gold medals have been awarded to Messrs. Mather & Platt, Limited, of the Salford Iron Works, Manchester:—(1) For dynamos for electric lighting and electrical transmission of power. (2) For electric lighting plant. (3) For incandescent lighting plant. (4) For motors.

Muirhead v. Caledonian Telephone Company.—On 15th inst Lord Stormouth Darling was to have heard evidence in the Court of Session, in an action by Andrew Muirhead, Cart Forge, Crossmyloof, Glasgow, against the Caledonian Telephone Company, 109, St. Vincent Street, Glasgow, but a settlement was mutually effected.

York Electric Lighting.—In regard to the electric lighting of the York Courts of Justice we understand that the dynamo and gas engine were supplied as stated by their respective makers, but, all connections and the temporary switchboard were designed and fixed throughout by Messrs. Benham & Sons, of Wigmore Street, W.

Arundel Castle Electric Lighting Station.—Messrs. Reed, Blight & Co., Ltd, contractors, Westminster, and Eagle Works, Plymouth, have secured the contract for erection of an electric light station at Arundel Castle, Sussex, for the Duke of Norfolk. Mr. A. F. Phillips, 21, Great George Street, Westminster, is the engineer.

Music by Telephone.—By the arrangement of Mr. John D. Miller, Dundee manager of the National Telephone Company, on Saturday evening last, a number of persons at Dundee enjoyed by telephone the music being performed at the theatres in Aberdeen, Glasgow, &c.

Saxby & Farmer.—We regret to hear of the death of Mr. John S. Farmer, which took place suddenly last week. The business, however, will continue to be carried on under the same management and on exactly the same footing as heretofore.

Annual Dinner.—The annual festival of the employés of Messrs. H. F. Joel & Co., was held at the "Crown and Cushion," London Wall, on Saturday last. There was a large meeting and everything was a success.

Private Lighting.—Messrs. Mavor and Coulson have fitted up some tea rooms at Charing Cross, Glasgow, with the electric light. The rooms were opened by Lady Kelvin last week who switched on the current.

Personal.—We understand that Mr. Joseph A. Jeckell has been made manager of the works belonging to the International Okonite Company, Limited, Newton Heath, Manchester.

A False Rumour.—There is a rumour current to the effect that the General Electric Company, Limited, of 71, Queen Victoria Street, are supposed to be partners or otherwise connected with and interested in the firm of Smeeton & Page, or that the General Company are doing a considerable amount of contracting work under Messrs. Smeeton's auspices. We are asked by the former company to announce that the only relation existing between themselves and the firm in question, is that of an ordinary customer. All rumours to the contrary are therefore false, as it has been the policy of the General Electric Company to supply goods only, but not to tender for erecting work of any kind.

North Eastern Telephone Company.—Regarding our notice in last week's issue, Mr. E. R. Widdicombe, manager of the North Eastern Telephone Company, Limited, writes us as follows:—"I notice that you have a paragraph inserted in this last week's issue of your paper to the effect that the North Eastern Telephone Company, Limited, is in voluntary liquidation, and as this is likely to lead to a misunderstanding, allow me to point out that the liquidation is purely a matter of form (as required by the Companies Acts), for reconstruction of the company."

CITY NOTES.

Woodhouse and Rawson United, Limited.

THE annual report of the directors for the year ending July 31st, 1892, reads as follows:—"The directors, in submitting their report upon the balance-sheet for the year ending July 31st, 1892, desire to express their regret that the favourable expectations which they entertained at the commencement of the year, and which they expressed in their last annual report, have not been realised. In common with almost all undertakings connected with electricity, your company has felt severely the competition of the past year, arising through the depression of trade, and this depression has told even more heavily on this company, because, acting on the manifest and frequently expressed desire of the shareholders that the industrial side of their operations should be developed, the board has, within the last 18 months, formed branches in the chief centres of electrical enterprise throughout England and the colonies. Many of these, as, for example, Sydney and Johannesberg, after some initial losses incident to their formation, have developed into promising undertakings, but the benefits likely to be derived from them do not show in the last year's balance-sheet. The result of these developments has been shown by the fact that whereas the turnover of the industrial portion of the company's business was, in the first year, £72,258, that of the second year was £126,015, and that of the year just concluded £151,121. On the other hand, the financial portion of the business, which has been repeatedly stated to the shareholders to be the most profitable, has, owing to the financial depression, been almost entirely suspended during the past year. In most of the company's branches there has been a loss more or less serious, due to a large extent to the unfavourable period which succeeded their formation. Owing to the number of these branches the aggregate of such losses would in any case have proved large, but some are so considerable as to require special notice. The failure of the arrangement for continuing the manufacture of incandescent lamps under the license of the British Electric Lighting Company, obliged the board during the past year to close down, at any rate for a time, a large portion of their Cadby Hall factory, which had been laid out for the purpose of this part of their business, and has also obliged them, as they are no longer at liberty to sell their lamps in the United Kingdom, to write down the value of their large stock by 75 per cent., the sale price of lamps abroad being only one-fourth of that realised in this country. Their valuable lamp plant has also depreciated largely from the same cause, as it cannot be utilised before the expiration of the Edison and Swan patent in November next. This has been one of the most serious blows to the progress of the company, but one which may be retrieved when they recover at that date the right of using their valuable patents, which have gained for the Woodhouse and Rawson incandescent lamp an established reputation throughout the world. The board would point out another serious disappointment in the industrial department during the past year. When the directors last met the shareholders they had obtained a valuable concession for lighting a large area of the richest part of Paris, and had entered into an agreement whereby they had secured the co-operation of one of the strongest firms in France, who undertook to provide over one-half of the capital required. This would not only have provided a large profit by the sale of the concession, but would have furnished employment for the company's works for some time to come. But owing to the insuperable difficulty experienced in raising the required balance of capital in this country, the advantages accruing to this company by the concession were lost. The newly acquired Kidsgrove and Chiswick works have also been the source of unexpected losses. In the latter case the board have reduced expenses to a mere nominal amount. The loss on the Kidsgrove works was mainly incurred in realising the assets, and carrying out the contracts taken over from the vendors. These contracts are now finished, and the works have been placed under capable management; they require only a sufficiency of capital to enable them to carry on an important and profitable business. The remainder of the loss is largely due to the large amount written off for depreciation of stock, which had been increased in the expectation of a demand which, unfortunately, did not arise. The union of Cadby Hall and Manchester under one management has proved most unsatisfactory; the directors have therefore recently placed the works at Manchester

under the separate management of tried and experienced officials of the company, and are reducing the business at Cadby Hall works to the execution of contracts in hand and actual orders, with a correspondingly large reduction of staff and standing charges. Notwithstanding, however, the serious check received by their industrial department through the causes above-mentioned, the directors consider that the company would have, to a great extent, recouped itself by the results of its financial enterprise, if the past year had presented any opportunity for launching an industrial company with a reasonable prospect of success. The Oncken Company, which their contract with the patentee obliged them to bring out by August 1st, yielded only shares as the profit of this company, and these do not appear in the present balance-sheet. The Epstein accumulator, which was introduced by this company, has proved a complete success as the most efficient and economical on the market. The Epstein Electric Accumulator Company, in which this company is so largely interested, has been manufacturing now on a commercial scale for the past six months, and the result of its operations has been to demonstrate that the Epstein accumulator has solved the difficulty of using accumulators for traction purposes. Owing, however, to the general financial position there has been no chance of realising the value of the Epstein patents, but it is expected that this company will derive large profits from them in the future. The directors are glad to be able to state that the reputation of the company is such that inventions of the most valuable description are constantly placed in the company's hands for development, a share of the patents being given for their services in this respect, and without any money payment on their part. During the last twelve months the board have given unceasing attention to the reduction of expenses, and they are glad to be able to state that their efforts have been successful. It is anticipated that a considerable further reduction will be effected within the next three months. The directors have relinquished their fees since last January. The directors regret to say that Mr. Philip Rawson was ordered by his medical adviser to abstain from all business for a time, and resigned his seat on the board in September last; Sir Edward Thornton also at a recent date requested the directors to accept his resignation. Your directors have not filled up the vacancies occasioned by these resignations, for they have felt that it was due to the shareholders that the appointment of directors should be such as might commend itself not merely to the directors themselves, but to the general body of shareholders. The auditors, Messrs. Jackson, Pixley, Browning & Co., retire in accordance with the articles of association, and offer themselves for re-election."

BALANCE SHEET, July 31st, 1892.

DR. LIABILITIES.	£	s.	d.
Share capital authorised—			
60,000 ordinary shares of £5 each	300,000	0	0
50,000 preference shares of £5 each...	250,000	0	0
	£550,000	0	0
Share capital issued—			
Ordinary shares of £5 each, 37,514 of £3 15s. called up, £140,677 10s; 17,683 fully paid, £88,415; preference shares of £5 each, 41,068 fully paid, £205,340; less due on calls, £7,400 17s. 6d. ...	427,031	12	6
Debenture stock, 5½ per cent., £118,187; less held as collateral security, £19,625; mortgage debenture bonds, 6 per cent., £65,500; less outstanding, £50	164,012	0	0
Pension fund	1,565	0	0
Bad debts, reserve	2,433	1	8
Sundry creditors—secured, £22,006 7s. 8d.; unsecured, £24,819 15s. 3d., bills payable, £12,488 5s. 8d.	59,314	8	7
	£654,356	2	9

ASSETS.

CR.	£	s.	d.
Freehold premises:—Cadby Hall, London, Union Foundry, Kidsgrove, £69,309 12s. 3d.; less mortgages thereon, £23,500	45,809	12	3
Leasehold premises in London and elsewhere ...	2,528	15	7
Plant, machinery and tools at Cadby Hall, less depreciation; Chiswick, Kidsgrove, and Manchester, per valuation	37,554	2	1
Stock (finished and unfinished) and merchandise at works, depôts, warehouses and branches, per valuation, £99,553 8s. 4d.; goods in transit, £1,379 17s. 10d.; expenditure on contracts in hand, £22,186 13s. 3d.	123,119	19	5
Sundry investments	101,847	5	0
Furniture and fittings	2,742	19	3
Sundry debtors, £73,278 12s. 4d.; bills receivable, £323 14s. 6d.	73,602	6	10
Goodwill	99,263	3	7
Moiety special expenditure on advertising, repayable by instalments	5,669	0	2
Patents, patent rights, &c.	73,450	18	1
Cash at bankers and in hand	2,033	16	8
Loss	86,734	3	10
	£654,356	2	9

PROFIT AND LOSS ACCOUNT for the Year ending July 31st, 1892.

DR.	£	s.	d.
Salaries, £7,764 8s.; printing and stationery, £1,030 13s. 3d.; postages and telegrams, £886 18s. 2d; legal expenses, £1,300 8s. 6d.; travelling expenses, £305 9s.; directors' fees, £2,000; less amount waived, £1,137 10s. = £862 10s. Patent fees, £862 8s. 1d.; rent, rates, insurance, &c., £2,660 6s. 9d.; royalties, £1,954 2s. 10d.; bad debts, £3,549 17s. 9d.; less reserve, £2,600 = £949 17s. 9d.; bad debt reserve, £1,773 15s. 10d.	20,350	18	2
Advertising, £5,688 0s. 8d.; catalogues, £761 12s.; exhibition expenses, £1,766 5s. 1d.	8,215	17	9
Debenture interest	9,350	18	2
Loss on lamp settlement and action, £14,472 11s. 3d.; loss at Kidsgrove, £17,784 6s. 4d.; loss on trading and depreciation of stock, plant and tools, £37,274 3s. 7d.	69,531	1	2
Depreciation on patents, £5,650 1s. 4d.; depreciation on investments, £26,012 10s.	31,662	11	4
	£139,111	6	7

CR.	£	s.	d.
Net profit at July 31st, 1891, £51,439 4s. 5d.; less appropriated to pay dividend, £43,408 16s. 10d. = £8,030 7s. 7d.; reserve fund, £35,000; brought forward from last year	43,030	7	7
Interest on loans and investments	7,554	18	8
Balance of discount account	379	10	0
Premiums, transfer fees, &c.	1,412	6	6
Balance, *i.e.*, loss, £129,764 11s. 5d.; less brought forward as above, £43,030 7s. 7d.	86,734	3	10
	£139,111	6	7

We have examined the above profit and loss account and balance-sheet for the year ending July 31st, 1892, but as we consider it desirable to refer to many of the items contained therein, we have made a special report to the shareholders, which report must be considered as part of this certificate.

JACKSON, PIXLEY, BROWNING, HUSEY & Co.,
Chartered Accountants, *Auditors.*

58, Coleman Street, London, E.C.,
December 12th, 1892.

The fourth ordinary general meeting of this company was held yesterday (Thursday, December 22nd) at Cannon Street Hotel, Sir Rawson W. Rawson presiding.

The SECRETARY having read the notice convening the meeting,

The CHAIRMAN said that the occasion of his addressing them was so important for the future of the company that he had committed to paper what he had to say, and requested permission to read it. There were several points into which he would have to enter at some detail, but they must excuse him because his object and the wish of his fellow directors was that they should give fullest information on all matters concerning the company, so that they might estimate correctly their position and prospects and form judgment as to the wisest course to be pursued. He commenced by analysing the losses which had taken place during the last year, as shown in the balance-sheet, in order to show the causes from which they had arisen, and to satisfy the shareholders, as he hoped to be able to do, that those causes were exceptional, and would not recur. The first of them, as shown in the profit and loss account, was that relating to the lamp settlement and action, amounting to £14,000 odd. They were aware that the company was prevented, by the result of the action of the Edison and Swan Company, from manufacturing or selling incandescent lamps in the United Kingdom, and, as a result of that injunction, they were prevented from utilising their valuable lamp patents, which had made the reputation of the Woodhouse and Rawson incandescent lamp. Subsequent to that action the company, under the best legal advice entered into an arrangement with the British Electric Light Company to work under the license which that company had obtained from the Edison and Swan Company. Owing, however, to a technical legal point, they found themselves, subsequently, in a position in which there was no alternative but to give up all attempts to continue the lamp manufacture, or to run the risk of incurring heavy damages at the suit of the Edison-Swan Company. By that means they were deprived of one of the principal expected sources of industrial profit from the beginning, and in order to settle the action of the Edison-Swan Company they had to incur the further loss mentioned, the major portion of which, however, was due to the necessary writing down of the stock and plant in the lamp department. They retained their lamp plant, and expected in next November, when the patents of the Edison-Swan Company expired, to resume the manufacture, with the advantage of the reputation they had already established for their incandescent lamps. They had also in the meantime disposed of a considerable portion of their stock at a rate above even that at

which they were now stated in the stock assets, on the Continent and abroad, where the Edison patent did not interfere with them. The next item in the profit and loss account was that at Kidsgrove, amounting to £17,000 odd, being losses on contracts taken over from the vendors, and works taken by them whilst in the service of the company, also to debts incurred by the failure of the vendors' firm. In the matter of Kidsgrove, the directors considered themselves justified in relying to a great extent on the judgment of their then business manager. The reports which he made to the board as to the value of the property spoke in unqualified terms of the advantageous character of the apparatus, of the excellent business that was being done, and the opportunities which the acquisition of the Kidsgrove works would offer for developing the other business of the company. They found at that time that it was absolutely necessary that they should manufacture certain classes of electrical apparatus and machines which they had not hitherto undertaken. Under the present management the contracts undertaken, with very few exceptions had been profitable, a large amount of business had been taken up and successfully carried out, and a still larger amount, reaching a total, as their manager informed them, of nearly £50,000, had been offered them during the last few months, which they could have undertaken had they had the necessary capital. The work done at Kidsgrove had given perfect satisfaction, and was entered to the reputation of the company for good work. The other item on which he would remark was the loss on the trading and depreciation, amounting to £37,000. As far as they could make out nearly £30,000 of that might be stated to be depreciation and not actual trading loss. A portion of the loss was due partly to agencies which had since been closed as unprofitable, and the initial expenses in the formation of new branches, several of which had only been in operation for the last four or five months, and were now beginning to pay their way. Among the most promising he would specially refer to Johannesburg, Sydney, and Paris. At Johannesburg, at present, they had about £15,000 stock, which would realise very lucrative prices, far beyond anything that they could obtain here or on the Continent. They were now beginning to reap the advantages of their agency in Australia. A great deal of the loss on trading was due to the working of their Cadby Hall factory, which, since the lamp business had become closed, could not possibly be carried on at a profit. Those works they proposed almost entirely to close after Christmas, for a while, transferring their manufactory to the Manchester and Kidsgrove works. There will henceforward be at Cadby Hall a rental of at least £250 a year received from a company who occupied one of the blocks, also a rental of another £200 a year from the Epstein Company so long as they continued to carry on their manufactory there, and the expense at Cadby Hall would be reduced to a very small item. By that means standing charges, which had amounted to as much as £6,000 a year, would be converted into an annual profit of £500 to £600, which would be increased to a very considerable amount as soon as they were able to resume their lamp manufacture, for which the premises and plant at Cadby Hall were originally designed. The depreciation of stock, plant, and tools represented no less than 25 per cent. of the cost price to the company, which the directors had thought wise to write off. They had felt that it was right to lay before them the actual position of the company in its plainest and fullest form, that they could say that they had not taken value for anything more than they believed their stock and plant, &c., was worth. The sum of £5,650 was the next item, for depreciation of patents, which was the proportion they had decided to write off each year from the accounts. He referred fully to the Epstein accumulator and the Oncken barrel patents. He had gone through the several losses shown in the balance-sheet, which he had explained, and which depended not so much upon losses in trading as upon depreciation of stock, which they could not help; depreciation of securities which not only they could not help, but which was not certain. What was worth only £1 to-day might next year be worth £2 or £3, or more, depending upon the market value under the existing financial and commercial depression, the depreciation of the securities that they held—not securities that they had bought—but securities that they held as part of the profit realised from the introduction of patents connected with electricity which had been brought out with the company's assistance. He next dealt with the special report of the auditors on the accounts, which was made in consequence of the books not having been balanced, and in consequence of certain items in the accounts not affording, by themselves, a sufficient explanation as to the position of affairs. The auditors stated that the books were not balanced, owing to the fact of the directors not having employed a sufficiently competent book-keeper. The accounts at the head office were exceedingly complicated, and involved, moreover, the incorporation of a number of branch accounts. The chairman stated that they were now in the charge of an experienced book-keeper. The auditors were not able to vouch for the payments in consequence of the vouchers not having been properly arranged, and a large number being missing. The chairman said that they were all small accounts, but, of course, they ought to have been laid before the auditor, and he assumed that between transfer from the head office to Cadby, some had gone astray. Since the last balance sheet the auditors reported, they were informed, that the expenditure had been properly treated in the accounts. Regarding the investments, £109,000, in companies either promoted by Woodhouse & Rawson or otherwise allied to them, the auditors were unable to express an opinion on the value of these, which had been handed them by the officials of the company, and was considerably below their nominal amount. On looking for the securities of those investments they found some of them were not in the hands of the company. The securities of the Sociedad Espagnole had been deposited in Barcelona, which was correct. The 215 debentures, of £100 each, in the International Okonite Company were deposited as a security for loss, and 34,000 shares in the Epstein Company were held by the chairman and managing director as security for them in respect of contracts, rent, and other matters. The sundry debtors amounting to £73,000, including an amount due from Mr. F. L. Rawson, the managing director, but the auditors were informed that that had been settled by being taken over by Woodhouse and Rawson, Limited, one of the original vendors of the company. The loss for the year appeared to be £122,000, assuming that the securities and the sundry debtors realised the amount taken credit for, also the stock, goods in transit, and contracts in hand amounting to £123,000, realised their value. The accounts, said the auditors, had been given them by the officials of the company, and they could not accept any responsibility as to the value put upon them. The chairman stated that with reference to the vouchers which still remained to be produced, the board had no doubt they would be shortly forthcoming, and the amount was not anything considerable. The question of repayment of the guarantee fund was one upon which it was due to the shareholders that he should enter into with some little detail, and he began by reading the paragraph of the original prospectus, which related to it. The company had cut down its expenses by a very large amount, and with the reductions which it contemplated carrying out before the end of the year, it would have got rid of all the sources of loss that had existed to the present time, and that they did not foresee. In the industrial portion of the business the incomings would then be more than equal to the outgoings, and they had every hope would bring in during the year a very fair profit, but for this purpose it was necessary to pay off the debts that they had incurred during the past, and provide an adequate balance for working capital, to enable the company to buy in cheap markets and maintain its credit. The directors estimated that the sum required, although not immediately, was £60,000, and they proposed to raise that sum by mortgaging their free investments, amounting to over £70,000, and the stock-in-trade and merchandise, which amounted at the date of the balance-sheet to nearly £100,000. That would not interfere with the existing debentures and debenture stock, as the profits would be chiefly used to pay off existing liabilities, nearly the whole of which at present were cleared upon securities and different accounts, and more especially to pay off the amount that they had borrowed upon their uncalled capital, thus saving the necessity of making a call which otherwise would be unavoidable. The rate of interest was a high one, namely, 10 per cent. per annum to the shareholders. The loan would be made for 12 months. The balance would enable them to undertake profitable contracts which had been offered.

In conclusion, the CHAIRMAN moved the adoption of the report, which was seconded by Sir GEORGE STOKES.

Dr. WM. SQUIRES (a shareholder) did not think it was likely that additional capital would be raised until a good deal more was known about the actual position of the company, and in order to raise that question, he proposed, in no hostile temper, to move that the report be not adopted, and that a committee of investigation, voted by the shareholders, should be formed. In the first year of its existence the company made an extremely magnificent profit—at least on paper; they paid 15 per cent. dividend, and in addition there was a surplus of £41,000, £30,000 of which was carried to the reserve fund, and the balance, some £16,000, was carried on to the following year. On the strength of that balance-sheet, the directors asked the shareholders to part with the sum which was originally lodged as a guarantee for dividend. Wonderful to relate, the shareholders consented to this. In the second year of the company's existence things were not so rosy, and although £51,000 was set down as profit it was not so much, for they had to subtract the sum of £16,000, which was carried forward; this was just sufficient to pay 15 per cent. to the ordinary, and 8 per cent. to the preference shareholders. Since then the picture had changed considerably, instead of the original magnificent profit they had the loss of £129,000. It was very difficult to supply any explanations for such an extraordinary change from prosperity to adversity. He had noticed that many industrial companies had begun well and collapsed shortly afterwards. They could make the profits for a year or two anything they liked. It was only necessary to get reckless gentlemen to value the stock, then they might put down goodwill and patents for any sum. The accountants had no check on these figures, and the result was a magnificent balance-sheet certified by well known accountants. But it is only for a time, for there were accumulations on the debit side and decreases on the asset side. He was not far wrong in saying that the £75,000, which was a guarantee for the payment of dividend, was the main inducement for investors. That being so, that fund should have been held as sacred. He (the speaker) opposed the proposal of the directors to pay back this guarantee fund. The position of the company, in his opinion, was far worse than the report showed. What was the value of the goodwill of a business which was losing £2,500 a week, yet they found that the goodwill had gone up a little. Practically the goodwill was worthless; £73,000 were put down as the value of patents. Now, a patent was a very doubtful property indeed. It was good to-day and bad to-morrow. A new invention might wipe out of existence many patents. All patents should be written down with the greatest possible speed. These valuable patents had already landed them in a lawsuit to the extent of £14,000. Various investments figured at £102,000, but he suspected that if these investments were realised, they would not fetch half the value assigned to them, many in fact would be absolutely unsaleable. The speaker then commented on the humiliating confession regarding the Kidsgrove works. This had landed them in a loss of £17,000. If all the scientific advisers of the company were such as those who advised on the Kidsgrove affairs, there was little wonder there was no profit. The speaker then commented adversely on the scattered branches of the company. In conclusion, the speaker moved for a committee of investigation.

Mr. BACON said he was sorry to be obliged to stand up to second

the amendment. The balance-sheet had come to him as a surprise. If a committee [of shareholders were appointed and the meeting adjourned, there would be an opportunity of the accounts being made up for the last few months which were not included in the report. It was necessary that the whole affairs of the company should be closely examined. After further remarks the speaker seconded the amendment.

Mr. GRIFFITHS and Mr. LOCKWOOD, shareholders, followed in the same strain.

Mr. POPE, Q.C., a director, said he was not going to speak as an advocate, for he was thoroughly ashamed of the balance-sheet. If they undertook to raise the debenture stock he would put £2,000 into the concern to-morrow. He could not conceive that any of the directors would object to a committee from the shareholders.

Mr. F. L. RAWSON, managing director, said there was not a man in the room who had lost one tithe of what he had. He regretted the report and balance-sheet, and felt he was to a great extent responsible, but there was no reason why, with greater attention to the industrial side of the business, they could not get on a sound footing again.

After many shareholders and directors had spoken, the chairman proposed that a committee of five of the principal shareholders should be appointed, and that a report for the last half-year be prepared. This was carried and a resolution authorising the Board to borrow £20,000 was carried.

The meeting, after a protracted sitting of four hours, then came to a close.

The Gülcher (New) Electric Light and Power Company, Limited.

THE directors' report reads as follows:—"Herewith the shareholders will receive the balance-sheet for the twelve months' ending June 30th, 1892. As indicated in the last report, the result of the chairman's visit to New Zealand shows a net profit to the company of upwards of £4,500. His absence, however, unexpectedly extending over 14 months, threw, during the whole of that period, an amount of work upon our then manager which he appears to have been unable to cope with, and while, owing in great measure no doubt to the depression which prevailed throughout 1891, the sales during that year fell off considerably, some of the contracts entered into were of an unfortunate character, the result being a manufacturing loss of £6,000 for the past financial year. In such a position of affairs the directors felt bound to accept his resignation, tendered in May last, and on July 1st the technical management of the company was handed over to Mr. W. B. Esson. The directors trust that the change of management will prove beneficial to the company. Mr. Hilton and Mr. Pryor retire by rotation from the board, but, being eligible, offer themselves for re-election. Mr. Russell Day, the auditor, also retires, but offers himself for re-election."

[Our representative was refused admittance to the meeting which was held yesterday.]

Electric Construction Corporation, Limited.

THE fourth ordinary general meeting of the above was held on Friday last, December 13th, at Cannon Street Hotel, Sir Daniel Cooper, Bart., G.C.M.G., presiding.

The SECRETARY (Mr. W. Samson) having read the notice convening the meeting,

The CHAIRMAN said :—Three months' ago I very reluctantly, at the entreaty of my colleagues, took the position of chairman of this corporation, and from the day I have held office until now my best endeavours have been to re-establish the credit of the corporation. I and my colleagues have stuck manfully to the ship, and have within a few weeks obtained for it a position it has never held since the day it commenced work. Since my election as chairman, the time for the corporation has been a critical one, but the directors, individually and collectively, have found money and credit, so as to enable us to meet all demands, but to do this they have had to incur responsibilities which I do not think any other board of directors would have done, but their faith in the soundness of the corporation, if well and carefully managed is such that they felt themselves secure, and they also felt sure that the shareholders would appreciate their efforts. The corporation when it started, had to make its name, like all new companies, and had to obtain work at times under onerous conditions. The profits earned therefore should not be gauged as they would be for an old and established company. I may instance the works at Manchester Square and near Rathbone Place; the Overhead Railway at Liverpool, the works at Oxford and the South Staffordshire Tramways. These important orders have to a great extent given the corporation a footing and a name in the trade, and are a guarantee for future orders of which we have now, according to what Mr. Parker says, from £60,000 to £70,000 in view. When the name of the corporation is established it will enable it to obtain contracts on more profitable terms. The experience, too, of the last three years, will enable the board to manage and guide the business more firmly and economically. The shareholders, as a body, have not supported the corporation as they ought to have done in the issue of the preference capital, and the directors have had to find the means among themselves to carry on the company, and, therefore, from their practical knowledge are convinced that it would be folly to declare a dividend. They now ask you to contribute towards the £100,000 second mortgage debentures, and let the directors have the satisfaction of seeing you help the corporation in the way they themselves have done. Mr. Duncan has issued a circular from a sick bed, and I have no doubt that his notions are none of the brightest or strongest. I may instance his remarks about the Electrical Power Storage, which was taken by this corporation at a large price. From the day it was taken over to the day it was leased to the present company the turnover gradually dwindled, and if it had continued to be conducted by E. C. Corporation, it would have vanished by this time; whereas, managed separately, it has regained in 12 months its old output and is still advancing, and this corporation is receiving a sum of £9,000 a year as a minimum; and as it holds the bulk of the shares in the undertaking, it practically receives all that is made by the E.P.S. Company. A Mr. Dunnill, the holder of a few shares, has also issued a circular, which I hope that the shareholders will treat respectfully, but I trust that they will not be led away into a scare, and so destroy absolutely their property by statements that can be easily and conclusively answered. The present directors, as I have said before, have done a great deal in a very short time to put the company on a firm footing, and they hope, with new blood, to do much more during the year to concentrate the resources of the company, and also to confine it to its legitimate work; but whilst they are doing this, they must not be harassed by the shareholders themselves, through a committee of investigation, which would only have a disastrous effect upon the credit and business of the corporation, already seriously injured by the attacks of hostile shareholders. At the same time there is no desire on the part of the directors to withhold any information which they can properly give to the shareholders. Please understand that we do not wish to conceal from the shareholders anything that we ought to disclose to you. The shareholders appoint the auditors of the company, Messrs. Broads, Patteson & Co., who are most able, most painstaking, and most independent, and would not pass any transaction that was not strictly correct. I am informed by our legal adviser that Mr. Dunnill's resolution is out of order, and cannot be moved; but nevertheless it may not be out of place for me to state the conclusion the directors have arrived at respecting it. In the first place let me say that I, myself, hold as large an interest in the corporation as the whole of the shareholders whose proxies Mr. Dunnill has obtained. I should not be in this position unless I had confidence in the company. I merely mention this to show that the board have a very substantial interest in the property of the corporation. The directors have carefully considered the proposal for the appointment of a committee in the resolution embodied in Mr. Dunnill's circular, and came to the conclusion that there were very grave objections to a committee. The directors of the board, as now constituted, have nothing whatever to conceal, and if they considered only their own feelings, would welcome the appointment of a committee, but they are perfectly satisfied that the appointment of this committee would be exceedingly detrimental to the interests of the corporation. Of this I may just give you an example. A foreign contract, which they had good hopes of securing, has gone past the corporation, on the statement by the gentlemen who had its disposal, that the rumours prevalent respecting the corporation, and suggestions of its inability to carry out the contract if they got it, had deterred him from offering it to the corporation. The final settlement of a contract which the corporation had hoped it had secured is now being suspended, waiting the result of this meeting, probably to see whether the directors held the confidence of the shareholders, and the corporation is in a position to carry out the contract.

A SHAREHOLDER: What is the amount of the contract?

The CHAIRMAN: Nearly £30,000. Continuing, he said:—But altogether, apart from these considerations, the directors cannot see that the appointment of a committee, or its report, could carry the weight with the shareholders of the examination into the affairs of the corporation which has just been made by the Electric and General Investment Company. That company was not a shareholder of the Construction Company, and had no interest in its affairs. When a loan to the company was proposed, it, as the report states, caused an exhaustive examination to be made of the books and accounts, and it had a report by an expert upon the works. The result is that they have agreed to provide £50,000, which, I may tell you, is absolutely necessary to carry on the business of the corporation. Surely these facts ought to carry more weight with the shareholders than the reports of ten committees. For these reasons the directors have come to the conclusion that they must resist as most prejudicial, I will not say fatal, to the corporation, the carrying of any such resolution as is indicated in Mr. Dunnill's circular. At the same time they must regard the passing of such a resolution as a vote of want of confidence in themselves. Gentlemen, I hope I have sufficiently impressed you with the gravity of the issue as affecting the future of the corporation. As I am suffering from a severe cold, the vice-chairman will now explain to you the figures of the balance-sheet, with which he, from his active participation lately in the affairs of the company, is better able to do than I am. We have had no managing director for some time, and a large corporation like this is very difficult to manage, unless you have somebody who gives almost constant attention. Mr. Courtenay, the vice-chairman, has been doing that without any pay whatever, and in that way he had got the details more at his finger ends than I have, because I cannot give the time nor come to the City as he does. With these observations I beg to move "That the report of the directors and the accounts annexed thereto be received and the same are hereby adopted."

Mr. J. IRVING COURTENAY, Vice-Chairman, in seconding the adoption of the report, said: I respond with pleasure to the call of the chairman (Sir Daniel Cooper), who has so gallantly come to the assistance of the corporation under the trying circumstances with which you are all more or less acquainted. I feel bound to state that this corporation owes a deep debt of gratitude for the splendid financial support given it by Sir Daniel Cooper in the hour of need, and he has been loyally aided by the present directors. I now propose to go through the profit and loss account and balance-sheet, and offer such explanations as may seem necessary. I am afraid they will be somewhat lengthy, but I have no doubt you will excuse me. Taking the profit and loss account first, the head office expenses, viz., £7,870 3s. 1d., are less than they were last year by £3,563 4s., which

I think you will agree is a substantial reduction, and the directors intend to still much further reduce these expenses. The amounts under the head of "special expenses" are very heavy, but the bulk of them may be deemed to be exceptional, and not likely to occur again; for instance, the chief amount in the allowances on contracts arose in the final settlement of accounts, in regard to one contract, namely, that with the Metropolitan Electric Supply Company, Limited. There were questions of vibration and annoyance, and other legal questions involved, and in the opinion of those who know the question best, the arrangement come to was a beneficial one for both parties interested. We are indebted for this friendly compromise to the kind offices of Sir Henry Mance and Sir John Pender. Another amount is for commission paid to the British Electro-Chemical Agency (one of the subsidiary companies) in consideration of a license for some of their patents which were essential for the proper working of patents which were sold by this corporation to the Phosphorus Company, Limited. You understand that the E.C.C. has a very considerable interest in the Electro-Chemical Agency. The last item of these "special expenses" is for outlay in connection with the Crystal Palace Exhibition. The corporation is bound to make a good display at electrical exhibitions, but following years benefit by the foundations thus laid for new business. Again, the maintenance of patents has been a heavy account in the past year, owing to the costs incurred in the important case, known as the "Lane-Fox Distribution Patent," which, I am glad to say, resulted in a judgment against Mr. Lane-Fox. This, again, is an expenditure the benefit of which will be felt in the future. We consider that some of the items under the head of special expenses might very fairly be chargeable to capital, at any rate, not wholly charged against the revenue of one year, but I assume you will approve of the board's action in writing off all these charges at once, which has the effect of very greatly strengthening the balance-sheet. Turning, now, to the balance-sheet, you will observe an item of £6,470 for difference between par value of shares sold and amount realised, which we have deducted from the reserve account set apart for this purpose; and this is a convenient opportunity for me to call your attention to the principle the board has adopted, with the approval of the auditors, which is, not to attempt to value the shares we hold in subsidiary companies at any other figure than their par value, but to create a large reserve fund as against them, so that when the shares are realised, should there be any deficiency, there will be an ample reserve to meet it. The reserve is independent of the £18,000 reserve for general purposes, and £10,000 for bad and doubtful debts. The amount of shares held by the corporation has been the subject of comment, but you will remember that a large proportion of these shares were acquired in payment for various patents sold or licensed by the corporation. We should, of course, have preferred to have got cash, but that was not possible. It became necessary to develop and work the numerous patents owned by the corporation, in some way or other, and on the best terms we could get, and this remark applies also to the provisional orders. For legal and other reasons separate companies had to be formed, and we hope that, in future, these subsidiary companies will be a source of considerable income, the corporation keeping itself to pushing and developing its manufacturing and contracting business, so far as practicable, upon cash terms only. You will have noted that there is a sum in cash, £3,115 15s. 9d., at the London and General Bank, Limited, which is now in liquidation, of which £3,000 is on a joint deposit account on behalf of one of the subsidiary companies, as a guarantee fund in connection with patents sold to them. No official statement of the prospects of this liquidation has yet been made, but we are assured that no loss will accrue so far as this deposit is concerned. As stated in the report, the directors do not propose that any dividend be paid on the ordinary shares for the past year, but recommend that the dividend, at the rate of 7 per cent. per annum, be paid on the preference shares to September 30th last, that £30,000 be placed to a suspense account, and that the balance of £26,862 1s. 5d. be carried forward. The directors believe this to be the sound course for men of business to take under existing circumstances, and that the shareholders will approve the policy. The directors will use every effort to realise some of the shares, and to make the balance of profit and loss account available for dividend purposes as soon as possible, and though the fixed charges are somewhat heavy, I see no reason, with strict economy, both at Bushbury and at the head office, why a satisfactory dividend should not be regularly earned in the future. I now come to the work done at our Bushbury works. The past year has been a very heavy one at the works. We have turned out an increase in the amount of work in our ordinary business, and have also put down a system of continuous current high pressure distribution of electricity for Oxford, and during the Exhibition at the Crystal Palace we delivered, by the same system, about 500 horse-power over a mile into the Crystal Palace from the station. The Oxford installation, we are informed by Mr. Parker, has proved to be thoroughly efficient and reliable, and it will stand among the first of the installations in this country in the future as a means of supplying energy for lighting and power. We have also carried out the contract for the Liverpool Overhead Railway Company, or very nearly so, putting down the whole of their power in the electrical portion of the engineering, carriages, and all necessaries for running the line. This line of railroad is expected to be in running order about the end of the year. We have manufactured and installed 7½ miles of an overhead system of tramways for the South Staffordshire Tramways Company, Limited, which is now shortly to be opened for traffic. This work has been highly praised by the Board of Trade inspector. These contracts have many novel features, and being the first of their kind do not admit of the profit that is to be made when regular business is established, but we may look forward to these being the pioneer enterprises of future great business in this class of work. The works are now thoroughly equipped, and their capacity can be largely extended with great advantage to the corporation, as the additional charges upon additional business would be very much less in proportion. Mr. Parker tells us he knows of a substantial amount of work in different directions, which he expects will be entrusted to this corporation to execute. The value of these contracts must not be gauged by the precise cash returns, but must be regarded rather as contained in the valuable advertisement from such important works as the Liverpool Overhead Railroad and the South Staffordshire Tramways. We have in the past year worked out in our laboratory several inventions for the more economical production of zinc, chlorine and alkalies; to carry some of these into practical effect the directors have founded the Electro-Alkali Company. These inventions promise success in our laboratories, and I hope that Mr. Parker may in a short time be able to report that their commercial application is equally successful. The alkali patents were in the first instance transferred with other patents to the Electro-Chemical Agency, but when, as the result of full experiments, Mr. Parker arrived at the opinion that the alkali patents promised to be of great value, it was considered best to put them into a separate company, and they were bought back for preferred shares in the Alkali Company from the chemical agency, and they are now the property of the Alkali Company, in which the E.C.C. has a very large interest. The chairman has already dealt with the remarks of Mr. W. W. Duncan about the Electrical Power Storage Company, which are, in some important particulars, incorrect. I shall, however, not be able to express myself so strongly as I should, had Mr. Duncan been here for me to speak to him face to face. The net profit when the Electrical Power Storage business was worked by the E.C.C. was never what Mr. Duncan states it was, nor are the annual costs of administration what he states; they are really about half the amount, because a portion of the account is for 17 months working, and a large sum is included for carriage, &c., which does not belong to administration account. I explained the figures to Mr. Duncan last autumn, when he remarked that my explanation had knocked the bottom out of his criticisms. He has thought fit to repeat them, but the reasons for his whole attack are obvious. Experience has shown that it is practically impossible to run successfully two businesses together which differ so much as do the storage battery and dynamo manufacturing business. The result is, that whereas the business had so seriously fallen off when it was worked by the E.C.C., that it had nearly reached the point where no profit could be earned at all, we have, since it has been worked separately, nearly doubled the output and are still increasing it. I think the shareholders would wish to hear further details from Mr. Parker of the important works I have alluded to, and later on I will ask him to address you. I now come to the important paragraph in the report dealing with the general financial position of the corporation. I may state at the outset that the problem of how additional capital could be raised, on terms which would be satisfactory to the shareholders, presented some difficulties, on account of the many interests which had to be protected. There is the first mortgage debenture issue at present of £150,000, then there are some preference shares, then come the ordinary shares, and finally there are the founders', whose rights have had to be safeguarded. I am glad, however, to be able to assure you that the scheme which the Electric and General Investment Company, Limited, after a very close study of the whole of the question (with the assistance of the most competent legal advice), has devised for us, is one which protects and preserves the rights of all existing interests, and in this connection it is right perhaps to tell you that we have had an advantage in dealing with the Electric and General Investment Company, Limited, which we would probably not have had if the arrangements had been made with others, by reason of the fact that the Electric and General Investment Company have a special knowledge of this class of industrial undertakings, and they have therefore been better able to appreciate the great potentiality for future work which this corporation possesses. The problem was, as to how £100,000 additional capital could be raised on terms which, while they are sufficiently attractive, are not unduly onerous to the corporation, and the result is, I feel bound to say, to the satisfaction of your board. We are raising £100,000 of new capital at a rate of interest at 6 per cent. per annum, which is no higher than the rate of interest paid upon your first mortgage debentures, and the scheme provides for this money to be repaid within a comparatively short period. Of course it will be obvious to everyone that the money could not be raised on such exceedingly advantageous terms without offering a bonus, and the form in which this is done is satisfactory both from the point of view of the future of the corporation, and also from that of the shareholders, who have the first right to subscribe the money. The bonus I speak of is given in the form of an income bond, which is attached to each debenture, and is of a corresponding amount, *i.e.*, the subscriber of every £10 second mortgage debenture receives a bonus bond of £10, free of all liability, and this income bond will commence to carry interest from the date on which the debenture is drawn and paid off at par. The rate of interest will be determined for each year by the dividend paid on the ordinary shares of the corporation for each preceding year. It is, perhaps, desirable that I should explain the procedure a little more fully by giving you an example:—Assuming that at the end of next year debentures to the amount of, say £4,000, are paid off, then the income bonds to the amount of £4,000, corresponding to the debentures which had been drawn, will commence to carry interest, and they will receive interest for the year 1894, at the same rate as the dividend that may be paid upon the ordinary shares for the year 1893. I have no hesitation in saying that, in my opinion, these debentures, with income bonds, constitute an exceedingly profitable investment, but I hope to be able to convince you that the terms are not unduly onerous to the corporation, because the board feel that the new capital will of itself produce the amount which is required to pay the interest thereon and to redeem the debentures, and if this expectation is realised it will be seen that the corporation will obtain the benefit of this increased earning power

at the cost of merely the interest paid upon the income bonds. On the other hand, the shareholders who subscribe for those debentures will make an exceedingly good thing, especially those whose bonds are drawn at an early date, because they will receive their principal back with 6 per cent. interest, and will at once rank with the ordinary shareholders for dividend without cost to themselves. This explanation of the scheme will, I think, make it clear to every shareholder that if he wants to secure the full benefit of the arrangement for himself he can do so by taking up his proportionate allotment. It is a great satisfaction to the directors that the board has been strengthened by the addition of the Right Hon. David Plunket and Mr. James W. Barclay, both of whom occupy so leading a position in the City of London, and with whose assistance the economies that must be effected in various directions will be judiciously and effectively carried out, and we feel confident that with the support of the shareholders the corporation can be made to take the first rank amongst the electrical properties of this country. I beg to second the resolution.

Mr. THOMAS PARKER (works manager and engineer) said: Mr. Chairman and gentlemen,—Our vice-chairman has spoken to you of the condition of the works at Wolverhampton, and what we have accomplished during the year. I, of course, do not mean to attempt any criticism of his speech, and he has in a great manner knocked out the bottom of what I was going to say. In Wolverhampton we have had a very heavy year, that is, the novelty of our engagements have thrown great work upon the staff and the factory, but that novelty was necessary to the progress of the business and its prospects for the future. We have therefore not been able to make a profit as we hope to in the future. In Oxford we have put down a continuous current system, which will no doubt tell in time as being a novelty, and not only a novelty, but one equally reliable and efficient. It has never yet been adversely criticised, and has been running for nearly a year, and it will no doubt be the forerunner of a great deal of business in the future, and we have secured valuable patents upon this system. The Liverpool Overhead Railway, as you may know, is the largest practical effort made at railway working, and we have run the first trains on it, and have carried the directors and the engineers, and I am pleased to see Sir Douglas Fox (the engineer for the work) here, and he will be able to testify to the manner in which we have carried out the work. These are great things to be engaged in, and the burdens falling upon myself and those immediately in connection with me are very heavy and difficult, but still I am patient, and I shall be always pleased if the shareholders are pleased to give me their support and satisfaction. That is what I crave; my great ambition has been to make this company successful; it is my life's work, and I appeal to the directors and the whole of the shareholders who know me and my work, whether I have not honestly and consistently and thoroughly done my duty to this company. The South Staffordshire Tramway is a system of tramways which we have put down and which are novel and the first of this kind carried through at the works. I mention this because, under these circumstances, all these contracts have run through this year. In taking the figures, it would seem that the profits have been small on the manufactory turnout at Wolverhampton, but by deducting the goods bought, such as engines, boilers, cables, &c., upon which the profits are small, it will be seen that the profits on the actual manufacture at Wolverhampton have been very good. We have in hand at the present time one-third of last year's orders. We have also in hand for special contracts, machinery for Manchester, for Leeds, Coatbridge and Burnley, and I am sorry to say that we cannot say for Wolverhampton, although the Wolverhampton authorities have passed the order to us in committee. We had also worked out in the laboratory some features which promise successful application, and on some of these patents the directors have decided to form the Electro-Alkali Company, Limited. Our vice-chairman has spoken about the Electro-Alkali Company, but I do not think I can strengthen his remarks. I hope these statements are satisfactory to you.

Mr. DUNNILL (a shareholder who had been issuing a circular to the general body of shareholders) here wished to know whether he could move a resolution of which he had sent the board notice.

The SOLICITOR to the company (Mr. Harold Brown) and the CHAIRMAN declared that the resolution was out of order. Notice had been received 24 hours too late.

Mr. DUNNILL said that having been ruled out of order, he would now move the following amendment: "That the accounts be not adopted nor passed; that the directors be required to amend the same by giving particulars of all the shares in subsidiary companies, licenses granted, and patents sold, and the amounts receivable in each case, and from whom; that this meeting be adjourned to enable this to be done, and that fresh accounts be delivered to every shareholder seven days before the adjourned meeting." Mr. Dunnill contended that in his circular he had put the case in a temperate manner. It was based entirely on the figures supplied by the directors themselves. The shareholders found, on looking into the accounts, that a large portion of their capital—more than £250,000—was not applied to the business of a manufacturing company at all, but was represented by exploiting companies and dealing in shares. They had some confidence that their business at Bushbury constituted a valuable asset; but they wanted to know what had become of the £250,000 which was represented by shares received or receivable. He contended that the shareholders should have a thorough investigation, which should be quite independent of the directorate. They wanted to know all the companies represented by the extraordinary amount appearing in the balance-sheet. What were the companies, and what was the present value of the shares? He also thought that strict enquiry into the proposal to issue £100,000 more capital should be instituted.

Mr. W. W. COOK seconded the amendment.

Mr. PEACHCROFT opposed the amendment, but thought the shareholders should be told something about the shares in the subsidiary companies. He considered that the company was now starting on a new era altogether, and that to have a committee of investigation would ruin it. With regard to the issue of £100,000 second mortgage debentures, and the scheme under which it was to be made, he should like to ask what would be the position of the income bondholders in the event of the liquidation of the company within, say, three months, though he did not for one moment suggest that such a thing was likely.

Mr. G. HERRING, chairman of the Electric and General Investment Company, said in the course of the business proceedings which had taken place lately between his company and this, his board made a thorough examination of the affairs of the Electric Construction Corporation. Prior to that they had had no commercial relations whatever. It was not possible for him to make known the report that was drawn up, but, for the gratification of the shareholders, he might tell them that it was to the effect that, although there had been some mistakes, there was nothing serious the matter, and that, with good management and a very trifling outlay of money, they should do well. His board was prepared to do something more than give barren advice, and with that idea they had drafted the scheme which was now before the shareholders.

Mr. MILLINGTON said he noticed among the directors a gentleman who had been associated with two or three companies in process of liquidation at the present time, and he wished to know if it were his intention to retire, for he thought it would be to the advantage of the company and the restoration of confidence that he should do so. He referred to Mr. Dibley, who was a director of the London and General Bank and other companies now in liquidation.

Mr. DIBLEY said he would at once retire from that or any other board if there could be, in the slightest sense, anything brought against him in connection with his being on the board of the London and General Bank. He could not think of retiring at the command of one or two persons, for if he did so he should be practically passing a vote of censure on himself, as if he had done something wrong.

After a long discussion,

The VICE-CHAIRMAN pointed out that it would be highly prejudicial to the interests of the corporation to publish a list of the subsidiary companies in which they had shares, but any shareholder would be shown the list privately at the office, and full information would be given in regard to each case. As to the value at which they were placed, the directors were supported by the auditors in the figure at which they were placed in the accounts.

The SOLICITOR (Mr. Harold Brown), replying to Mr. Peachcroft's question as to whether, in the event of liquidation, the income bonds would exist as well as the second mortgage debenture bonds, said he must confess that as the document stood it looked as if that was the case, though it was not the intention.

Mr. HERRING said that was certainly not the intention with which the scheme was drafted, and he had not thought it bore that interpretation until, on the previous day, Mr. Peachcroft had pointed it out. The intention was that the income bonds should have no existence until the "elder brother" was put out of existence.

The SOLICITOR had no doubt that point could be adjusted.

Mr. DUNNILL was strongly appealed to to withdraw his amendment, but said he felt bound to press its being put.

The amendment was then put and lost, only five shareholders supporting it.

Mr. DUNNILL said he must demand a poll, but

The SOLICITOR quoted from the articles to prove that no poll could be taken either on the question of the election of a chairman or the adjournment of a meeting.

The original motion was then put and carried *nem. con.*

Mr. DUNNILL said he must demand a poll on that.

This caused much uproar among the shareholders, and there were cries from all parts of the room, "Withdraw!"

Ultimately, on its being pointed out to Mr. Dunnill that the board had a large majority in proxies, apart from the sense of the meeting, the demand for the poll was withdrawn.

The retiring directors, Mr. James Pender and Mr. John B. Verity, were re-elected, as were the auditors, Messrs. Broads, Patteson & Co.

Mr. MILLINGTON wished to take the sense of the meeting as to a request to Mr. Dibley to retire from the board, but his proposal was ruled out of order.

Dr. DRYSDALE proposed a "vote of confidence, not thanks," to the chairman and directors, and this terminated the proceedings.

A poll was taken among the shareholders at the close of the meeting as to whether Mr. Dibley should be removed from the board; not that there was anything to be proved against him, but because he having been connected with certain undertakings, it might be detrimental to the corporation.

The proceedings were private.

Crompton Electric Supply Company of Australia.

THE third annual general meeting of the above company was held on Monday last at the offices of the company, Mansion House Buildings. Mr. J. F. Albright in the chair.

The SECRETARY (Mr. Francis B. Reeves) having read the notice convening the meeting, a copy of which appeared in last week's ELECTRICAL REVIEW,

The CHAIRMAN said: Gentlemen, as you have heard the notice read by the secretary convening this meeting, you will know that this meeting was convened because it is our duty to meet you before the end of this year 1892. We had hoped to have been in a position to lay the accounts before you up to May 31st, 1892, but, unfortunately, they have been delayed. We have been expecting to receive them almost every mail. One of the chief reasons why the accounts have been delayed, as far as we can gather from our reports from the other side is, that we ourselves in London have been in the past very stringent in endeavouring to see that the accounts were satisfactory and to protect your interests, and we have insisted very stringently

on certain points with the auditors in Sydney. The result has been, in regard to this year's acccounts, that the auditors have, as it were, thrown the ball back to us and have been extremely strict in regard to the exact method of the stock-taking, and this has been one of the chief reasons of delaying the accounts. I have little doubt in my own mind that another reason is the fact mentioned in a letter received by a very recent mail from Sydney, that one of the managers, Mr. Whiffin, is again unfortunately ill. I hope that these facts will be received as sufficient explanation of the difficulty in which we have been placed. I mentioned that Mr. Whiffin is unfortunately ill, and that brings me to another point which I should like to deal with in regard to our business. Some time ago—about seven or eight months—we had the question of supplementing the management in Sydney very strongly brought to our notice, largely on account of the fact of Mr. Whiffin's ill-health. This matter has received our most careful attention, and certainly my co-directors and myself have spared no pains to do the best we could to select a manager, to send out to Sydney to supplement the management. We have obtained an extremely good gentleman in Mr. K. H. Buchanan, and about a fortnight ago we received a cable from Sydney that he had arrived, and we therefore trust that he is now getting established in his position, and that we shall ere long feel the benefit of his assistance. You will be well aware that business in the Australian colonies, for some time past, has not been in a very flourishing condition, and this feature has been prominently dwelt upon in the newspapers. Although we anticipate that the accounts which we are now waiting for will also show to some extent this falling off in business, our more recent advices give us considerable encouragement as to a revival of business in our particular branch. There is another question that we, as directors, wish to bring before you. It has been very evident to us for some time past, that the subscribed capital of the company is insufficient to deal thoroughly and profitably with all the business which the company might advantageously handle. Considerable business is lost for want of capital, and, of course, a business which is insufficiently strong in the financial direction cannot buy so cheaply or so well as if it had plenty of money. Having carefully considered this question, the directors have decided that the best way of supplementing the capital will be by the issue of debenture bonds forming a first charge on the company's assets, and bearing interest at 7 per cent. per annum. These they propose to offer to the shareholders for subscription next month, giving the members the first option of subscribing to them. It is, of course, almost needless for me to point out that should any of the shareholders wish to take up any more of the 10 per cent. preference shares, which are the basis of our present capital, they can take that course. In further reference to this question of capital issue, we have felt the absolute necessity of increasing our capital, and we also felt that it is probably not such an issue as will be likely to be taken up by the outside public, therefore we have to rely almost entirely upon ourselves and our personal friends, and our own shareholders for support in this direction. Whatever we may be able to do as directors in getting personal support outside the present body of shareholders I am not prepared at present to forecast, but we wish it to be distinctly felt and understood that the existing shareholders have this debenture issue offered to them first, and it is only in the event of our receiving no support, or insufficient support, from them that we should attempt to get it subscribed for by people outside the existing body of shareholders. He then introduced Mr. W. Trotter, J.P., one of the committee of management in Sydney, who would give some information as to the state of things in Australia.

Mr. TROTTER said that he had undoubted faith in the future of the company. He thought they had been handicapped in the past by small excusable errors on both sides of the water. He referred to difficulties causing the delay in sending the accounts, distances being so great, and a portion of their stock being at Broken Hill, which was some 1,500 miles from Sydney. Then there was a large strike at Broken Hill, and it was impossible to get the stock away, and that delayed the accounts, and the auditors, seeing how particular the London people were, would not pass the stock until it was in Sydney. After a few remarks regarding Mr. Whiffin's illness, he went on to refer to the contracts. They had completed some very important works, one of the most important ones—the earliest—being for the *Daily Telegraph* Newspaper Company, whose premises were entirely lighted by electricity. That was a very large daily newspaper, and the work was so thoroughly done that they had never had to stop for an hour, and the work had been done about three years ago. They had done other sundry work in Sydney. Another large contract was the installation of the town lighting at Nhill, in Victoria. Another was the Proprietary mine at Broken Hill. Then there was the lighting of Tamworth, New South Wales, entirely by electricity. All these, amongst others, had proved quite satisfactory. Crompton's work, he said, would stand the test with any work in that particular branch of business. That, he believed, was very satisfactory to the shareholders to know. Whatever they had done was of a substantial character, and Crompton's name stood first among engineers and electricians in Sydney. They had just now a large contract for Perth, Western Australia, and they had in view the Sydney lighting. They were trying to get a Bill through Parliament to give them power to light a certain area of Sydney for private and street use. Negotiations were pending with the City Council to see if they could work with them to get their co-operation, but that of course took a long time. The Bill had passed its second reading, and in a short time would go for its third. He then referred to the question of the new capital, which he considered was absolutely necessary.

Mr. THOS. R. TUFNELL, Senr. (shareholder) complained regarding the accounts, and thought that although they were put off like this, they might let them know something about a dividend, as in either of the speeches this had not been referred to. He also asked regarding the large number of contracts which Mr. Trotter had said were in hand, whether those contracts would be profitable.

It was explained to Mr. Tufnell that it was impossible to say anything regarding dividend until the accounts had been received. It would not be long, they hoped, before the meeting would be held, and the accounts presented.

The resolution adjourning the meeting was unanimously adopted, as was also a resolution authorising the issue of first mortgage 7 per cent. debentures, to an extent not exceeding £10,000.

The meeting closed with a vote of thanks to the chairman and directors.

The Yorkshire House-to-House Electricity Company, Limited.

THE directors' report to June 30th last, to be presented to the ordinary general meeting of the company on Wednesday, the 28th inst., states that a freehold estate in Whitehall Road, Leeds, immediately behind the Great Northern Railway Station hotel, containing upwards of an acre, admirably adapted for the company's purposes, and having the advantage of a river frontage, has been purchased. The property includes several workshops and other buildings, which are not at present required by the company, and from which a rental is being derived. The erection of works has been vigorously pushed forward, but it has been found impossible to complete them as soon as was expected, and it will probably be early in the coming year before they are in operation. Underground culverts, about 10,000 yards in length, for the reception of distributing cables, have been laid, and the drawing in of the cables is now in rapid progress. An arrangement was made with the Highways Committee of the Leeds County Council for the necessary trenching to be undertaken by their staff, by whom the work has been admirably and expeditiously done. The applications for supply of current already received are sufficiently numerous to lead the directors to anticipate a successful business for the company. The whole of the present directors haviug been appointed under Article 77, their appointment will require confirmation by the shareholders. The retiring directors, Mr. Grosvenor Talbot and Mr. Robert William Eddison, being eligible, offer themselves for re-election. Mr. John Gordon, jun., offers himself for election by the company as auditor.

Elmore's Foreign and Colonial Patent Copper Depositing Company, Limited.

THE directors' report reads as follows:—The directors have pleasure in submitting the balance-sheet and profit and loss account for the financial year of the company ending December 31st last, showing a balance at that date of £132,203. The year in question has been one of establishment and development of the French and German Elmore factories, which were started in the latter part of 1890 under the auspices of this company, and the directors are glad to be able to say that the company working in France has now thoroughly proved the process on a large scale. The German company, although they have had their difficulties, are now also making good progress, and will, in the near future, certainly make a success of their business. The Elmore manufactures are now admitted to be superior to anything else of the kind in competition with them, and this fact is being recognised by the highest authorities and the most exacting customers. The recent report issued by the directors of the French company, in which this company holds a very large interest, shows the comparatively low price of manufacture, whilst the steadily increasing output, and the fact that that company is supplying a great number of consumers without any complaints from them, in several cases having received over 20 repeat orders, is the best proof of the success of the process on a large scale, and of the uniform quality of the products. The directors cannot at this time recommend the payment of a dividend, but they hope to be able, in the course of 1893, to make a distribution to the priority shareholders, leaving a handsome amount in hand for distribution among the founders. At the present moment, taking the company's assets at par value, and after setting aside £5 per share and a fourth of the balance for the priority shares, or an extra £2 15s. per share, there remains an amount equal to £13 per share for the founders. The company still hold a large number of patents for working the Elmore process in various foreign countries, the most important being Belgium, Italy, South America, India and the colonies, and negotiations are on foot for the sale of some of the more valuable of these. In accordance with the articles of association, one-third of the present board of directors retire from office. Upon this occasion Mr. F. L. Rawson retires, and being eligible, offers himself for re-election. Messrs. Jackson, Pixley, Browning, Husey & Co. offer themselves for re-election as auditors of the company.

BALANCE-SHEET, December 31st, 1891.

DR.	£	s.	d.
To Nominal capital—15,000 priority shares of £5 each, fully paid, £75,000; 9,000 founders' shares of £5 each, fully paid, £45,000	120,000	0	0
„ Sundry creditors	5,008	3	1
„ Sundry creditors for money advanced, £9,000; less securities held, as *per contra*, £9,000.			
„ Profit and loss account—Balance as per account...	132,203	1	1
	£257,211	4	2

Cr.	£	s.	d.
By Purchase of patents as last year	80,000	0	0
„ Sundry investments at cost price—Elmore's French Company, shares, £63,300; Elmore's German Company, shares, £58,758; Elmore's French Company, debentures, £18,258 8s.; Elmore's German Company, debentures, £25,704 3s. ...	166,020	11	0
„ Investments given as security for loan to Elmore's French Company, as *per contra*	9,000	0	0
„ Sundry debtors	1,336	5	11
„ Cash in hand and at bankers	726	3	11
„ Office furniture	128	3	4
	£257,211	4	2

PROFIT AND LOSS ACCOUNT for the Year ending December 31st, 1891.

Dr.	£	s.	d.
To Directors' and auditors' fees and salaries	2,369	10	0
„ Maintenance of patents and legal charges ...	4,833	17	6
„ Rent, rates and taxes	187	1	7
„ Stationery, printing and advertising	117	14	4
„ Travelling expenses	13	19	0
„ General office expenses	59	4	5
	7,581	6	10
„ Balance carried to balance-sheet	132,203	1	1
	£139,784	7	11

Cr.	£	s.	d.
By Balance from last year, £152,167 0s. 11d.; less dividend of £1 per share on 15,000 priority shares, paid February 4th, 1891, £15,000 ...	137,167	0	11
„ Interest	2,522	5	0
„ Transfer fees	95	2	0
	£139,784	7	11

We have examined the above accounts with the books and vouchers of the company, and certify the same to be in accordance therewith. The maintenance of patents and legal charges, £4,833 17s. 6d., include an agreed amount of £3,000 as being the proper proportion payable by this company in connection with experiments and improvements connected with the Elmore processes, the benefits of which are shared also by other companies,

JACKSON, PIXLEY, BROWNING, HUSEY & Co.,
Chartered Accountants, Auditors.

58, Coleman Street, E.C.,
April 5th, 1892.

The Morecambe Electric Light and Power Company.

THE second annual ordinary meeting of the shareholders of the above company was held at the West View Hotel, Morecambe, on Tuesday last week, Mr. W. B. Hodgson presiding.

The CHAIRMAN, in moving the adoption of the report and balance-sheet, said the duty was a pleasant one in view of the satisfactory result of the company's first season's operations. The directors at first had little thought or hope of so soon achieving a paying position, but were impressed with confidence of ultimate success by the amount of purchase money for the Parliamentary rights having been rigorously cut down to a figure considerably below the actual cost incurred by the undertakers, Messrs. Andrews and Preece, Limited. That firm had expended over £1,100 for what that company took over for £945, and such was their goodwill and real interest in the concern that they were content to take up £760 of the amount in shares, and also to give their valuable services as engineers without remuneration until the company reached a paying position. The directors were unable to induce the confidence of any save a few of the business men of the town, and the capital subscribed for was not large; they had, however, the fullest confidence that the exercise of good business methods, and the closest economy that could be practised, would accomplish results that influence alone could not; they therefore gave time, thought and effort to the work ungrudgingly, and with the secretary (Mr. Jowett) put aside all idea of recompense until the undertaking was in a position to stand it. Many difficulties had to be grappled with and overcome, but the various works had steadily progressed and the installation increased and been perfected. The profit, £74 9s. 11d., might seem small, but this was because of the greater cost in having to use Morecambe town gas instead of the "Dowson" gas, which they manufactured themselves, the plant for which could not be completed until October. The profit was further reduced by £22 odd interest on borrowed money. As they might reasonably expect the profits for next year to be much larger, they hoped they would not be materially reduced by the item of interest. Mr. Hodgson then gave a few particulars of the present financial position of the company, from which it appeared that the amount expended on plant was £3,112, and the amount to pay £1,588, total £4,700; against which £2,870 had been subscribed in share capital, exclusive of the 760 shares accepted in lieu of cash, so that there remained a balance of £1,830 to be taken up in new shares. It would also be seen that debenture bonds for £1,000 had been issued, in order to partially make up for the deficiency in subscribed capital. He strongly impressed upon the shareholders the desirability of making an effort to subscribe for the £1,800 required among themselves, and thus increase their holding in what would ultimately prove a valuable property. To non-shareholders the shares were at a premium at present; but this premium would of necessity have to be waived if shareholders failed to subscribe for the deficiency he had indicated.

Mr. MABBOTT seconded the resolution, which was carried unanimously. He then moved that a dividend of 5 per cent. on the "called-up" paid share capital be declared.

This was seconded by Mr. SCHOFIELD, and at once adopted.

On the motion of Mr. CRABTREE, seconded by Mr. TWYEROULD, the retiring director, Mr. W. C. Farrar was re-appointed.

The CHAIRMAN said that Mr. Morgan, the chairman of the company, not seeing his way to attend the meetings of directors, on account of living at Scarborough, had tendered his resignation. The directors accepted this resignation with great regret, and he therefore asked for nominations to fill the vacancy.

Mr. ANDREWS proposed Mr. Twyerould.

This was seconded by Mr. BLAND.

Mr. WILSON suggested that four directors were not sufficient, the whole of the business being practically left to three.

On being put to the meeting, Messrs. Twyerould, Hollingworth and Wilson were unanimously elected.

Mr. J. Duff (Halifax) was also re-appointed auditor.

The CHAIRMAN brought forward a recommendation of the directors that the accounts in future be made up to the end of December, instead of November 12th, as this would be more convenient in every way. Also that the annual meetings be held in the first week of February each year.

This was unanimously agreed to.

The Hove Electric Lighting Company, Limited.—This company has been formed with a capital of £40,000, in 8,000 shares of £5 each. Two thousand of these shares have already been subscribed for by the directors and their friends. The objects of the company are to take over from the Commissioners of Hove, Sussex, the undertaking comprised in the Hove Electric Lighting Order, 1890, for the supply of electricity for public and private lighting and heating, and as a motive power throughout the whole of the town. Applications already received for supply are said to be numerous, and the work of wiring shops and houses is going forward rapidly. The Commissioners are at present receiving proposals for the wiring of the Town Hall and Municipal Buildings, also for lighting the streets, and there is every prospect of the company having a large and successful business ere long. A contract has been entered into with Messrs. Crompton & Co., Limited, to lay necessary mains and supply and erect generating and distributing station, with plant on the low pressure system, and storage batteries sufficient to meet a demand of supplying 18,000 8-C.P. lamps, and to start same in proper working order, for the sum of £35,000. The directors are: Col. A. J. Filgate, R.E. (chairman), Col. H. Wood, C.B. (vice-chairman), H. A. Hoare, C. F. Tufnell, J. Wilkes. Consulting engineers, Crompton and Co., Limited. Secretary, F. R. Reeves, M.I.E.E., F.I.S.

Scottish House-to-House Electricity Company, Limited.—With a nominal capital of £100,000, divided into 20,000 shares of £5 each, of which 19,900 are ordinary shares, and 100 are founders' shares, this company has been registered for the purpose of supplying electricity throughout the whole of the burgh of Coatbridge. The present is an issue of £30,000, in 6,000 ordinary shares of £5. A contract has been entered into with Messrs. J. E. H. Gordon & Co., for the erection of a station with a capacity of 6,000 8-C.P. lamps, and the company will be able to wire at least 9,000 incandescent lamps. The directors are Peter McLagan, M.P., D.L., J.P., T. Bost, J. Hannay, G. Fleet, W. D. Cawney, C.A. The consulting electrical engineer is W. A. Bryson, F.R.S.E., M.I.E.E. The subscription list closed on Monday last.

Eastern Telegraph Company.—The Eastern Telegraph Company, Limited, announce the payment on January 13th next of interest of 3s. per share, less income tax, being at the rate of 6 per cent. per annum on the preference shares for the quarter ending December 31st, and the usual interim dividend of 2s. 6d. per share on the ordinary shares, free of income tax, in respect of profits for the quarter ended September 30th. The transfer books will be closed from January 6th to 13th, both days inclusive.

Arcas Plating Company, Limited.—The above company has been registered with a capital of £80,000 in £1 shares. There are at present offered for subscription 65,000 £1 shares. The objects are "To acquire and work the British patents for the valuable discovery known as the Arcas process for the electro-deposition of an alloy of silver." The directors are Edward Wolseley, T. Harrison Lambert, J. H. Mortimer Scott, G. M. Parker. Secretary and offices (*pro tem.*), J. A. Coombe, 19, Great Winchester Street, E.C. The subscription list closed on Wednesday, 21st inst.

Crompton and Company, Limited, have declared interim dividends for the six months ending September 30th last at the rate of 7 per cent. per annum on the preference shares, and 5 per cent. on the ordinary shares, payable on the 21st inst.

Elmore's French Patent Copper Depositing.—Warrants have been posted for the 10 per cent. dividend on the preference share capital for the half-year ended November 1st.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending December 18th, 1892, amounted to £918; corresponding month, 1891, £788; increase £130; total receipts for half-year, 1892, £20,657; corresponding period, 1891, £18,586; increase £2,071

SHARE LIST OF ELECTRICAL COMPANIES.

Present Issue.	Name.	Stock or Share.	Closing Quotation, December 15th.	Closing Quotation December 22nd.	Business done during week ending December 22nd, 1892. Highest.	Lowest.
195,100*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	100 —103	100 —103	...	...
1,247,720*l*	Anglo-American Telegraph, Limited	Stock	49½ — 50½	49½ — 50½	49¾	...
2,876,140*l*	Do. do. 6 p. c. Preferred	Stock	91 — 92	91 — 92	91½	91
2,876,140*l*	Do. do. Deferred	Stock	10⅜ — 11¼xd	10¼ — 10⅜	11	10⅜
130,000	Brazilian Submarine Telegraph, Limited	10	10⅜ — 11¼	10⅜ — 11¼xd	11	10⅜
34,600*l*	Do. do. 5 p. c. Bonds	100	101 —104	101 —104	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	106 —110	106 —110	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	3 — 3¼	3 — 3¼	3¼	3
75,000	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2⅛ — 2⅜	2⅛ — 2⅜	2⅜	2⅛
40,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	3 — 4	3 — 4	...	...
600,000*l*	City and South London Railway	Stock	35 — 38	35 — 38	37½	...
40,000	City of London Elec. Lighting Co., Ltd., Ord. 40,001-80,000 ...	10	10¼ — 10⅜	10¼ — 10⅜	10⅝	...
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000	10	5 — 5½	5 — 5½	5⅝	5½
$7,716,000	Commercial Cable, Capital Stock	$100	175 —185 xd	175 —180 xd	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ..	14/-	3/16 — 5/16	3/16 — 5/16	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	5 — 5½	5 — 5½	5⅝	5½
16,000	Cuba Telegraph, Limited	10	11½ — 12½	11½ — 12½	12¼	...
6,000	Do. do. 10 p. c. Preference	10	17½ — 18½	17½ — 18½	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	2½ — 3½	2½ — 3½	...	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	11 — 11½	11⅛ — 11⅜	11 5/16	11 3/16
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅝ — 14⅞	14⅝ — 14⅞	14 15/16	14⅝
70,000	Do. 6 p. c. Preference	10	15⅝ — 16½	15⅝ — 16½	16	...
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	107 —110	107 —110	...	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	109 —112	109 —112	110½	110
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	14⅝ — 14⅞	14⅜ — 15	14 1/16	14⅝
70,600*l*	{ Do. 5 p. c. (Aus. Gov Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326 }	100	1 4 —107	104 —107	...	...
250,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	104 —107	104 —107	...	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	109 —112	109 —112	110½	110
122,400*l*	{ Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343 }	100	104 —107	103 —106	104½	103½
163,700*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	104 —107	104 —107	...	...
300,000*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	103 —106	103 —106	...	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	2½ — 3	2½ — 3	2⅞	2⅝
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	.. ..	...	...
100,000	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	⅜ — ⅝	⅜ — ⅝	½	...
82,395	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	½ — 1	⅝ — ⅞	⅞	...
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	⅜ — ⅝	½ — ¾	¾	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	9⅜ — 10	9⅜ — 10	10	9¾
180,042	Do. do. 6 p. c. Preference	10	14⅞ — 15½	14⅞ — 15⅛	15 1/16	15
150,000	Great Northern Tel. Company of Copenhagen	10	19½ — 19⅝	19½ — 19⅝	20	19⅜
210,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	104 —107	104 —107	106	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	4½ — 5½	4½ — 5½	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	8 — 9	8 — 9	...	...
50,000	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	21 — 22	21½ — 22½	21⅞	...
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	102 —104	102 —104	...	...
17,000	Indo-European Telegraph, Limited	25	44 — 46	44 — 46	45	44¼
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	2½ — 3½	2½ — 3½	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	6 — 7	6 — 7	...	...
30,000	†Liverpool Electric Supply, £3 10s. paid	5	3 7/16 — 3 9/16	3 9/16 — 3 11/16	...	...
10,000	Do. do. fully paid	5	5 1/16 — 5 3/16	5 1/16 — 5 1/16	5¼	4⅞
38,348	London Platino-Brazilian Telegraph, Limited	10	4 — 6	4 — 6	...	...
100,000*l*	Do. do. 6 p. c. Debentures	100	108 —111	108 —111	...	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	6½ — 7	6½ — 7	6⅝	6⅝
50,000*l*	Do. 5 p.c. debentures, 1 to 5,000 in bonds of £10, £20, £40	...	101 —104	102 —105	...	...
454,747	National Telephone, Limited, Nos. 1. to 438,984	5	4⅜ — 5 xd	4⅜ — 5 xd	4 15/16	4 13/16
15,000	Do. 6 p. c. Cum., 1st Preference	10	14½ — 15½xd	14 — 15 xd	...	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	13⅜ — 14½	13⅜ — 14½xd	...	...
90,950	Do. 5 p. c. Non-cum. 3rd Pref., Nos. 1 to 90,950 ...	5	4 — 4½xd	4¼ — 4½xd	4¼	...
726,477*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	112 —114	112 —114	114	113⅜
48,800	New Telephone, Limited, Nos. 25,901 to 74,700 ... (£2 paid)	10	4⅜ — 5	4⅜ — 5	...	...
6,318	Notting Hill Electric Lighting Company, Limited, fully paid ...	10	5 — 6	5 — 6	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	3/16 — 5/16	3/16 — 5/16	...	...
11,202	Reuter's Limited	8	7½ — 8½	7½ — 8½	...	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	7⅜ — 8½	7⅜ — 8½	8 3/16	...
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	8½ — 8⅝	8½ — 8⅝	8⅝	...
3,381	Submarine Cables Trust	Cert.	116 —120	116 —120	...	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	3 — 3½	3 — 3½	3½	...
37,350	Telegraph Construction and Maintenance, Limited	12	45 — 47	45 — 47	45½	...
150,000*l*	Do do. do. 5 p. c. Bonds, red. 1894	100	103 —106	103 —106	...	...
58,000	United River Plate Telephone, Limited	5	2½ — 3	2⅜ — 3½	...	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	90 — 100	90 — 100	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	6½ — 7½	6½ — 7½	...	...
260,900*l*	Do. do. do. 5 p. c. Debentures	100	100 —103	100 —103	101⅜	...
30,000	West Coast of America Telegraph, Limited	10	2½ — 3½	2½ — 3½	...	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	104 —108	104 —108	...	...
64,242	Western and Brazilian Telegraph, Limited	15	7 — 7½	7 — 7½	7½	...
33,129	Do. do. do. 5 p. c. Cum. Preferred	7½	5½ — 5⅝	5½ — 5⅝	5⅝	5⅝
33,129	Do. do. do. 5 p. c. Deferred	7½	1½ — 1⅝	1½ — 2	1⅝	...
184,100*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	106 —109	106 —109	...	...
230,100*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	106 —109	106 —109	...	...
88,321	West India and Panama Telegraph, Limited	10	1¼ — 1½	1⅛ — 1⅜	1¼	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	10 — 10½	10 — 10½	...	...
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	8 — 9	8 — 9	...	...
80,000*l*	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	105 —108	105 —108	...	...
$1,536,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	120 —125	120 —125	...	...
171,000*l*	Do. do. 6 p. c. Sterling Bonds	100	100 —103	100 —103	...	...
59,900	Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	5½ — 6	5½ — 6	5⅞	...

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange. BANK RATE OF DISCOUNT.—3 per cent. (October 20th, 1892).

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Blackpool Electric Tramway Company, Limited, £10 (£6½ paid) 7½—7⅞.—Brush Company 4½ per cent. Debenture stock, issued at 1 per cent. premium, 100—103.—Electric and General Investment, shares of £5 (£1 paid) 1⅞—2¼xd.—Founders' shares, 200—225.—Electric Construction Corporation, 6 per cent. Debentures, 95—98.—Electricity Supply Corporation, Ordinary of £5, 5—5½.—Elmore Foreign and Colonial Copper, Founders shares, 6½—7½.—European Sims-Edison Torpedo Company, shares £20 (fully paid), 20—20½.—Founders' shares, 10—20.—Halifax and Bermuda Cable 4½ per cent. bonds 80—90.—House to House Company (£5 paid) 1½—2½.—Do. 7 per cent. Preference of £5, 5⅛—5⅜.—Do. 6 per cent. Debentures of £100, 97—102.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5—5½, 1st Preference Cumulative 6 per cent., £5 (fully paid), 6—6¼.—Liverpool Electric Supply Shares of £5 (fully paid), 5⅞—6⅛.—Manchester, Edison and Swan Company, £9 (£1 paid), ⅛—⅜.—Queen Anne's Mansions Lighting and Heating, Deferred shares of £10 (fully paid), 10—⅛.—Do. 4½ per cent. Preference shares of £10 (fully paid), 10—⅛.—Do. Debentures, 101—103.—Woodhouse & Rawson Ordinary of £5 (£2 10s. paid), ⅛—¼.—£5 Preference (fully paid), ½—1½.

PROCEEDINGS OF SOCIETIES.

The Institution of Electrical Engineers.

EXPERIMENTAL RESEARCHES ON ALTERNATE CURRENT TRANSFORMERS. By J. A. FLEMING, M.A., D.Sc., F.R.S., Member. (Read November 24th.)

(*Continued from page* 746.)

Ferranti Transformers, 1892 *type*, 15 *and* 20 *H.P.* (Tables XV., XVI., XVII., XVIII., XIX., XX).

These new transformers of Mr. Ferranti's are exceedingly good transformers. The total loss on open circuit of the 20 H.P. is only 1·3 per cent. of the full secondary output. The maximum efficiency is 97·1 per cent., and the efficiency at $\frac{1}{10}$th of full load is 85 per cent., whilst the total secondary drop is only 2·1 per cent.

Two sets of curves are given for the transformer of 15 H.P. size. In two transformers tested there was a difference in the winding which resulted in the total internal loss being greater in one than in the other. In the transformer having the greatest total loss the copper losses ($c^2 r$) are least, and the "secondary drop" diminished, therefore, about 1 per cent. The efficiency curve of all these transformers is very square shouldered, owing to the high efficiency (about 85 to 87 per cent.) at $\frac{1}{10}$th of the full secondary load.

TABLE XV.—*Ferranti Transformer* (1892 *Pattern*).

No. 2,194. Power = 15 H.P. Secondary volts = 100.
Frequency used, 81·6 periods per second.
Volts on primary circuit (v_1) = 2,400 (kept constant).
Primary circuit resistance = 6·45 ohms.
Secondary circuit resistance = 0·0134 ohm.

Secondary circuit.			Primary circuit.				Total power taken up in transformer.		Efficiency $\frac{w_2}{w_1}$, in per cents.
					Watts.				
Volts.	Ampères.	Watts, w_2.	Volts.	Ampères.	By dynamometer wattmeter, w_1.	By Swinburne wattmeter.	By dynamometer wattmeter, $w_1 - w_2$.	By Swinburne wattmeter.	
100·4	0	0	2,400	0·076	149	117	149	117	0
100·3	0·80	80	,,	0·100	222	201	142	121	36·0
100·3	2·68	269	,,	0·170	419	397	150	128	64·2
100·2	4·83	484	,,	0·270	637	617	153	133	75·9
100·1	8·06	807	,,	0·400	951	956	144	149	84·9
100·0	10·35	1,035	,,	0·503	1,189	1,196	154	161	87·0
100·0	12·33	1,233	,,	0·590	1,391	1,408	158	175	88·7
99·9	14·23	1,422	,,	0·670	1,580	1,612	158	190	90·0
100·0	16·19	1,619	,,	0·745	1,762	—	143	—	91·8
99·8	23·50	2,345	,,	1·050	2,506	—	161	—	93·5
99·7	25·22	2,514	,,	1·120	2,648	—	134	—	95·0
99·7	29·12	2,903	,,	1·265	3,064	—	161	—	94·9
99·6	32·98	3,285	,,	1·368	3,461	—	176	—	94·5
99·4	39·60	3,936	,,	1·695	4,120	—	184	—	95·5
99·3	44·18	4,387	,,	1·867	4,564	—	177	—	96·0
99·1	47·32	4,690	,,	1·980	4,878	—	188	—	96·1
98·8	49·96	4,936	,,	2·135	5,265	—	229	—	93·7
98·8	57·68	5,700	,,	2·466	5,947	—	245	—	96·0
98·8	62·36	6,160	,,	2·653	6,378	—	218	—	96·6
98·7	65·24	6,430	,,	2·771	6,680	—	250	—	96·2
98·5	69·62	6,858	,,	2·960	7,085	—	227	—	96·9
98·2	75·16	7,381	,,	3·187	7,618	—	237	—	96·9
98·0	78·80	7,722	,,	3·341	8,040	—	318	—	96·1
98·0	83·42	8,175	,,	3·521	8,501	—	326	—	96·2
98·0	87·90	8,614	,,	3·715	8,932	—	318	—	96·5
97·6	93·15	9,092	,,	—	9,495	—	403	—	95·8
97·6	97·29	9,495	,,	—	9,900	—	405	—	96·0
97·5	102·54	9,998	,,	—	10,415	—	427	—	95·9
97·4	105·48	10,274	,,	—	10,700	—	426	—	96·0
97·2	109·50	10,621	,,	—	11,120	—	477	—	95·5
97·0	113·04	10,965	,,	—	11,496	—	531	—	95·2
97·0	114·63	11,120	,,	—	11,690	—	570	—	95·4
100·1	0	0	,,	—	152	115	152	115	0

Mordey Transformer, 6,000-*watt*. (Tables XXI. and XXII.)

Two transformers of this size were tested. In one the three-voltmeter method showed the power loss at no load to be 125 watts; in the other the dynamometer wattmeter gave 148 watts. If we take the mean of these results, we get 136 watts as the open-circuit loss. This is 2·27 per cent. of 6,000 watts.

We found the "total secondary drop" between no load and full load to be 1·9 per cent. of the voltage at no load. In the official publications of the Brush Company the manufacturer's figures, for this sized transformer, for the open-circuit loss as a percentage of full load is given as 1·82 per cent., and the percentage total drop is 2·25 per cent., but these figures refer to the 6-kilowatt transformer worked at a frequency of 100 ~ and transforming from 2,000 to 100 volts. As the transformer tested by us had a transformation ratio of 24 to 1 and worked at 83 ~, it is a question how far the official figures may be applied to it; but, at any rate, our determinations agree with those

TABLE XVI.—15-*H.P.* (1892 *pattern*) *Ferranti Transformer*.

Primary volts, 2,400 (kept constant).
Secondary volts at no load = 100·4

Primary Current i_1.	Secondary current i_2.	$\frac{i_2}{24}$.	Copper losses in watts.			Total secondary drop in volts.	Primary watts.		Power factor, $\frac{w_1}{v_1 i_1}$.
			Primary, $i_1^2 \times 6{\cdot}45$.	Secondary, $i_2^2 \times 0{\cdot}0134$.	Total.		Real, w_1.	Apparent, $v_1 i_1$.	
0·076	0	0	0	0	0	0	149	188	0·82
0·100	0·80	0·033	0·1	0	0	0·1	222	240	0·92
0·170	2·68	0·112	0·2	0·1	0	0·1	419	408	1·03
0·270	4·83	0·202	0·5	0·3	1	0·2	637	647	0·98
0·400	8·06	0·336	1·0	0·9	2	0·3	951	960	0·99
0·503	10·35	0·431	1·6	1·4	3	0·4	1,189	1,210	0·99
0·590	12·33	0·515	2·2	2·0	4	0·4	1,391	1,416	0·98
0·670	14·23	0·594	2·9	2·7	6	0·5	1,580	1,600	0·99
0·745	16·19	0·674	3·6	3·5	7	0·4	1,762	1,788	0·99
1·050	23·50	0·980	7·1	7·4	15	0·6	2,506	2,520	0·99
1·120	25·22	1·051	8·1	8·5	17	0·7	2,648	2,688	0·99
1·265	29·12	1·213	10·4	11·4	22	0·7	3,064	3,036	1·01
1·368	32·98	1·373	12·1	14·5	27	0·8	3,461	3,283	1·05
1·695	39·60	1·650	18·6	21·0	40	1·0	4,120	4,068	1·01
1·867	44·18	1·841	22·5	26·2	49	1·1	4,564	4,481	1·02
1·980	47·32	1·975	25·3	30·0	55	1·3	4,878	4,752	1·02
2·135	49·96	2·081	29·4	33·4	63	1·6	5,265	5,124	1·03
2·466	57·68	2·404	39·3	44·6	84	1·6	5,947	5,918	1·00
2·653	62·36	2·600	45·5	52·0	98	1·6	6,378	6,367	1·00
2·771	65·24	2·721	49·5	57·1	107	1·7	6,680	6,650	1·00
2·960	69·62	2·901	56·4	65·0	121	1·9	7,085	7,104	1·00
3·187	75·16	3·138	65·6	75·5	141	2·2	7,618	7,649	1·00
3·341	78·80	3·286	72·0	83·2	155	2·4	8,040	8,018	1·00
3·521	83·42	3·478	80·0	93·0	173	2·4	8,501	8,450	1·00
3·715	87·90	3·661	89·1	103·5	193	2·4	8,932	8,916	1·00
3·900	92·34	3·846	97·0	114·0	211	2·6	9,390	9,360	1·00
4·089	97·00	4·040	107·8	126·0	234	2·7	9,980	9,813	1·02
4·276	101·50	4·237	118·1	138·1	256	2·9	10,300	10,502	0·98
4·483	106·32	4·440	130·0	152·0	282	3·1	10,790	10,759	1·00
4·548	107·67	4·485	133·2	155·5	289	3·3	10,978	10,915	1·00
4·648	109·98	4·588	139·2	162·0	301	3·3	11,210	11,155	1·00
4·762	112·89	4·708	146·4	171·0	317	3·4	11,496	11,429	1·00

TABLE XVII.—*Ferranti Transformer* (1892 *pattern, rewound*).

No. 2,193. Power 15 H.P. Secondary volts = 100.
Frequency used, 82·5 periods per second.
Volts on primary circuit (v_1) = 2,400 (kept constant).
Primary circuit resistance = 3·77 ohms.
Secondary circuit resistance = 0·0092 ohm.

Secondary circuit.			Primary circuit.				Total power taken up in transformer.		Efficiency $\frac{w_2}{w_1}$, in per cents.
					Watts				
Volts.	Ampères.	Watts w_2.	Volts.	Ampères.	By Dynamometer wattmeter, w_1.	By Swinburne wattmeter.	By Dynamometer wattmeter, $w_1 - w_2$.	By Swinburne wattmeter.	
100·0	0	0	2,400	0·103	229	—	229	—	0
99·9	1·20	120	,,	0·150	351	—	231	—	33·2
99·9	2·68	268	,,	0·212	492	—	224	—	54·5
99·9	4·81	481	,,	0·300	715	—	234	—	67·3
99·9	8·06	805	,,	0·412	1,023	—	218	—	78·6
99·9	12·25	1,224	,,	0·591	1,466	—	242	—	83·6
99·8	18·11	1,807	,,	0·833	2,032	—	225	—	89·0
99·8	23·45	2,340	,,	1·053	2,564	—	224	—	91·2
99·7	28·91	2,885	,,	1·292	3,136	—	251	—	92·1
99·6	34·64	3,450	,,	1·529	3,728	—	278	—	92·5
99·5	39·50	3,931	,,	1·723	4,189	—	258	—	94·0
99·3	45·39	4,507	,,	1·967	4,770	—	263	—	94·5
99·1	50·40	4,995	,,	2·181	5,260	—	265	—	95·0
99·0	56·00	5,544	,,	2·408	5,841	—	297	—	95·0
100·0	—	—	,,	—	214	—	214	—	—
98·9	61·58	6,090	,,	2·646	6,391	—	301	—	95·3
98·8	67·06	6,626	,,	2·877	6,957	—	331	—	95·1
98·7	73·76	7,280	,,	3·156	7,645	—	365	—	95·3
98·6	80·80	7,968	,,	3·447	8,349	—	381	—	95·5
98·5	88·10	8,678	,,	3·752	9,103	—	425	—	95·4
98·3	95·00	9,338	,,	4·025	9,791	—	453	—	95·4
98·1	101·82	9,989	,,	4·331	10,473	—	484	—	95·5
98·0	105·99	10,387	,,	4·499	10,901	—	514	—	95·3
97·9	108·33	10,608	,,	4·613	11,162	—	554	—	95·1
97·8	112·08	10,962	,,	4·762	11,559	—	597	—	94·9
97·8	113·85	11,135	,,	4·837	11,742	—	607	—	94·9
100·0	0	0	,,	0	244	—	244	—	0

TABLE XVIII.—15 *H.P.* (1892 *pattern, re-wound*) *Ferranti Transformer.*

Primary volts, 2,400 (kept constant).
Secondary volts at no load = 100·0.

Primary current, I_1.	Secondary current, I_2.	$\frac{I_2}{24}$	Copper losses in watts.			Total secondary drop in volts.	Primary watts.		Power factor, $\frac{W_1}{W_1'}$
			Primary $I_1^2 \times 3{\cdot}77$.	Secondary $I_2^2 \times 0{\cdot}0092$.	Total.		Real, W_1.	Apparent, W_1'.	
0·103	0	0	0	0	0	0	229	247	0·93
0·150	1·20	0·050	0	0	0	0·1	351	360	0·97
0·212	2·68	0·112	0·2	0	0	0·1	492	508	0·97
0·300	4·81	0·200	0·3	0·2	1	0·1	715	720	0·99
0·412	8·06	0·334	0·6	0·6	1	0·1	1,023	990	1·03
0·591	12·25	0·510	1·3	1·4	3	0·1	1,466	1,418	1·03
0·833	18·11	0·765	2·6	3·0	6	0·2	2,032	1,919	1·06
1·053	23·45	0·977	4·2	5·2	9	0·2	2,564	2,527	1·01
1·292	28·91	1·203	6·3	7·7	14	0·3	3,136	3,101	1·01
1·529	34·64	1·443	8·8	11·0	20	0·4	3,728	3,669	1·01
1·723	39·50	1·647	11·2	15·6	27	0·5	4,189	4,135	1·01
1·967	45·39	1·890	14·6	19·0	34	0·7	4,770	4,721	1·01
2·181	50·40	2·100	18·0	23·3	41	0·9	5,260	5,234	1·00
2·408	56·00	2·334	21·9	28·8	51	1·0	5,841	5,779	1·01
2·646	61·58	2·568	26·4	35·0	61	1·1	6,391	6,350	1·00
2·877	67·06	2·800	31·1	41·3	72	1·2	6,957	6,905	1·01
3·156	73·76	3·072	37·6	50·0	88	1·3	7,645	7,574	1·01
3·447	80·80	3·366	44·7	60·0	105	1·4	8,349	8,273	1·01
3·752	88·10	3·670	53·0	71·3	124	1·5	9,103	9,005	1·01
4·025	95·00	3·959	61·2	82·8	144	1·7	9,791	9,660	1·01
4·331	101·82	4·242	70·8	95·0	166	1·9	10,473	10,394	1·01
4·499	105·99	4·416	76·2	103·0	179	2·0	10,901	10,818	1·01
4·613	108·33	4·514	80·2	108·0	188	2·1	11,162	11,171	1·00
4·762	112·08	4·670	85·4	115·7	201	2·2	11,559	11,429	1·01
4·837	113·85	4·744	88·1	119·0	207	2·2	11,742	11,609	1·01

TABLE XIX.—*Ferranti Transformer* (1892 *pattern.*)

No. 2,184. Power, 20 H.P. Secondary volts = 100.
Frequency used, 82·7 periods per second.
Average final temperature of transformer, 98 F.
Volts on primary circuit (v_1) = 2,400 (kept constant).
Primary circuit resistance = 2·75 ohms at 98° F.
Secondary circuit resistance = 0·0061 ohm at 98° F.

Secondary circuit.			Primary circuit.				Total power taken up in transformer.		Efficiency $\frac{w_2}{w_1}$, in per cents.
					Watts.				
Volts.	Ampères.	Watts, w_2.	Volts.	Ampères.	By dynamometer wattmeter, w_1.	By Swinburne wattmeter.	By dynamometer wattmeter, $w_1 - w_2$.	By Swinburne wattmeter.	
100·0	0	0	2,400	0·112	230	195	230	195	0
100·0	1·91	191	„	0·173	420	373	231	182	45·5
99·9	4·08	408	„	0·274	646	587	238	179	63·2
99·9	4·82	482	„	0·304	709	664	227	182	68·0
99·9	6·16	616	„	0·350	861	795	245	179	71·6
100·0	8·12	812	„	0·424	1,046	989	234	177	77·7
100·0	10·29	1,029	„	0·524	1,270	1,208	241	179	81·0
100·0	12·28	1,229	„	0·602	1,470	1,426	241	197	83·6
100·0	14·28	1,428	„	0·685	1,682	1,621	254	193	84·9
100·0	19·06	1,906	„	0·884	2,116	—	210	—	90·2
99·8	24·98	2,493	„	1·130	2,722	—	229	—	91·5
99·7	30·98	3,089	„	1·378	3,336	—	247	—	92·6
99·7	34·64	3,454	„	1·538	3,711	—	257	—	93·1
99·7	39·80	3,968	„	1·740	4,216	—	248	—	94·1
99·6	45·44	4,526	„	1·975	4,758	—	232	—	95·2
99·5	51·22	5,097	„	2·220	5,372	—	275	—	94·8
99·3	57·68	5,728	„	2·500	6,047	—	319	—	94·8
99·2	65·48	6,496	„	—	6,780	—	284	—	95·7
99·1	72·88	7,223	„	3·124	7,525	—	302	—	96·2
99·0	79·50	7,871	„	3·400	8,215	—	344	—	95·8
98·9	86·82	8,587	„	3·690	8,933	—	346	—	96·2
98·8	93·20	9,208	„	3·965	9,543	—	335	—	96·5
98·8	100·48	9,928	„	4·271	10,307	—	379	—	96·3
98·7	108·31	10,691	„	4·614	11,000	—	309	—	97·1
98·5	114·48	11,277	„	4·866	11,602	—	325	—	97·2
98·3	121·92	11,985	„	5·184	12,373	—	388	—	97·0
98·3	127·56	12,539	„	5·440	12,959	—	420	—	97·0
98·1	134·97	13,241	„	5·754	13,676	—	435	—	97·0
98·0	141·99	13,915	„	6·040	14,375	—	460	—	96·9
97·9	146·10	14,303	„	6·222	14,828	—	525	—	96·5
97·9	148·56	14,544	„	6·312	15,052	—	508	—	96·6
97·9	151·44	14,828	„	6·500	15,322	—	504	—	96·9
100·0	0	0	„	0	228	195	228	195	0

TABLE XX.—20-*H.P.* (1892 *pattern*) *Ferranti Transformer.*

Primary volts, 2,400 (kept constant).
Secondary volts at no load = 100·0.

Primary current, I_1.	Secondary current, I_2.	$\frac{I_2}{24}$	Copper losses in watts.			Total secondary drop in volts.	Primary watts.		Power-factor, $\frac{W_1}{W_1'}$
			Primary $I_1^2 + 2{\cdot}75$.	Secondary $I_2^2 + 0{\cdot}0061$.	Total.		Real, W_1.	Apparent, W_1'.	
0·112	0	0	0	0	0	—	230	269	0·86
0·173	1·91	0·079	0	0	0	—	422	416	1·00
0·274	4·08	0·170	0	0	0	0·1	646	657	0·98
0·304	4·82	0·201	0·2	0	0·2	0·1	709	729	0·97
0·350	6·16	0·256	0·3	0	0·3	0·1	861	840	1·03
0·424	8·12	0·338	0·5	0·4	1	—	1,046	1,017	1·03
0·524	10·29	0·429	0·7	0·6	1	—	1,270	1,257	1·01
0·602	12·29	0·511	1·0	0·9	2	—	1,470	1,445	1·02
0·685	14·28	0·595	1·3	1·2	3	—	1,682	1,643	1·02
0·884	19·06	0·794	2·1	2·2	4	—	2,116	2,121	1·00
1·130	24·98	1·040	3·5	3·8	7	0·2	2,722	2,712	1·00
1·378	30·98	1·290	5·2	5·8	11	0·3	3,336	3,307	1·01
1·538	34·64	1·443	6·5	7·3	14	0·3	3,711	3,691	1·00
1·740	39·80	1·659	8·3	9·5	18	0·3	4,216	4,176	1·01
1·975	45·44	1·895	10·7	12·5	23	0·4	4,758	4,740	1·00
2·220	51·22	2·140	13·6	15·8	29	0·5	5,372	5,328	1·01
2·500	57·68	2·401	17·2	20·0	37	0·7	6,047	6,000	1·01
3·124	72·88	3·038	26·9	32·4	59	0·9	7,525	7,498	1·00
3·400	79·50	3·310	31·8	37·8	70	1·0	8,215	8,160	1·00
3·690	86·82	3·620	37·5	45·8	83	1·1	8,933	8,856	1·01
3·965	93·20	3·881	43·3	50·4	94	1·2	9,543	9,516	1·00
4·271	100·48	4·195	50·0	61·7	112	1·2	10,307	10,250	1·00
4·614	108·31	4·513	58·4	70·7	129	1·3	11,000	11,074	0·99
4·866	114·48	4·770	65·0	80·0	145	1·5	11,602	11,678	0·99
5·184	121·92	5·061	74·0	89·0	163	1·7	12,373	12,434	0·99
5·440	127·56	5·315	81·3	99·5	181	1·7	12,959	13,056	0·99
5·754	134·97	5·624	91·2	109·4	201	1·9	13,676	13,810	0·99
6·040	141·99	5·916	100·0	123·0	223	2·0	14,375	14,496	0·99
6·222	146·10	6·087	106·5	128·2	235	2·1	14,828	14,933	0·99
6·312	148·56	6·190	110·0	135·0	245	2·1	15,052	15,149	0·99
6·500	151·44	6·310	116·0	138·0	254	2·1	15,322	15,600	0·98

TABLE XXI.—*Mordey Transformer.*

No. 1,868. Power, 6,000 watts. Secondary volts, 50 and 100.
Frequency used, 82·9 periods per second.
Volts on primary circuit (v_1) = 2,400 (kept constant).
Primary circuit resistance = 7·73 ohms.
Secondary circuit resistance = 0·0163 ohm.

Secondary circuit.			Primary circuit.				Total power taken up in transformer.		Efficiency = $\frac{w_2}{w_1}$ in per cents.
					Watts.				
Volts.	Ampères.	Watts, w_2.	Volts.	Ampères.	By dynamometer wattmeter, w_1.	By Swinburne wattmeter.	By dynamometer wattmeter, $w_1 - w_2$.	By Swinburne wattmeter.	
101·1	0	0	2,400	0·076	148	105	148	105	0
101·1	1·00	101	„	0·100	246	217	145	116	41·0
101·1	2·97	300	„	0·173	461	417	161	117	65·1
101·1	4·83	488	„	0·269	646	600	158	112	75·6
101·1	6·60	667	„	0·357	836	800	169	133	79·8
101·1	9·00	910	„	0·447	1,071	1,047	161	137	84·8
101·0	12·04	1,216	„	0·562	1,378	1,368	162	152	88·3
101·0	15·07	1,522	„	0·692	1,690	1,668	168	146	90·1
101·0	16·91	1,708	„	0·769	1,904	—	196	—	89·7
100·9	19·90	2,008	„	0·900	2,177	—	169	—	92·5
100·8	22·93	2,311	„	1·019	2,521	—	210	—	91·6
100·7	25·41	2,559	„	1·127	2,736	—	177	—	93·5
100·6	28·35	2,852	„	1·253	3,044	—	192	—	93·7
100·5	31·18	3,134	„	1·368	3,366	—	232	—	93·1
100·4	33·94	3,408	„	1·490	3,622	—	214	—	94·1
100·2	36·82	3,689	„	1·615	3,889	—	200	—	94·9
100·0	39·75	3,975	„	1·735	4,203	—	228	—	94·6
100·0	42·76	4,276	„	1·863	4,516	—	240	—	94·5
100·0	45·56	4,556	„	1·980	4,775	—	219	—	95·5
99·9	48·37	4,832	„	2·105	5,089	—	257	—	95·0
99·7	50·64	5,049	„	2·195	5,316	—	267	—	94·9
99·6	53·36	5,315	„	2·300	5,596	—	281	—	95·0
99·5	56·14	5,586	„	2·431	5,895	—	309	—	94·8
99·4	57·96	5,762	„	2·510	6,061	—	299	—	95·1
99·3	60·00	5,958	„	2·592	6,266	—	308	—	95·1
99·2	61·58	6,109	„	2·668	6,420	—	311	—	95·4
101·3	0	0	„	0·076	150	108	150	108	0

of the manufacturer very fairly in assigning a value of not far from 2 per cent. both to the open-circuit loss and total secondary drop.

According to our observations this transformer takes rank as one of the best for regulation, having regard to its size and its open-circuit

TABLE XXII.—*Mordey Transformer.*

Primary volts, 2,400 (kept constant).
Secondary volts at no load = 101·1

Primary current, I_1.	Secondary current, I_2.	$\frac{I_2}{24}$	Copper losses in watts.			Total secondary drop in volts.	Primary watts.		Power-factor, $\frac{w_1}{W_1}$.
			Primary, $I_1^2 \times 7{\cdot}43$.	Secondary $I_2^2 \times 0{\cdot}0063$	Total.		Real, w_1.	Apparent, W_1.	
0·076	0	0	0	0	0	0	148	182	0·81
0·100	1·00	0·042	0	0	0	0	246	240	1·02
0·193	2·97	0·124	0·3	0·1	0·4	0	461	463	1·00
0·269	4·83	0·202	0·5	0·3	1	0	646	655	0·99
0·357	6·60	0·275	1·0	0·7	2	0	836	854	0·98
0·447	9·00	0·375	1·5	1·3	3	0	1,071	1,070	1·00
0·562	12·04	0·501	2·4	2·4	5	0·1	1,378	1,348	1·02
0·692	15·07	0·627	3·7	3·7	7	0·1	1,690	1,660	1·02
0·769	16·91	0·705	4·6	4·7	9	0·1	1,904	1,845	1·03
0·900	19·90	0·830	6·3	6·5	13	0·2	2,177	2,160	1·01
1·019	22·93	0·955	8·0	8·6	17	0·3	2,521	2,445	1·03
1·127	25·41	1·060	9·8	10·6	20	0·4	2,736	2,705	1·01
1·253	28·35	1·181	12·2	13·1	25	0·5	3,044	3,007	1·01
1·368	31·18	1·300	14·5	15·8	30	0·6	3,366	3,283	1·02
1·490	33·94	1·414	17·2	18 8	36	0·7	3,622	3,576	1·01
1·615	36·82	1·536	20·2	22·1	42	0·9	3,889	3,876	1·00
1·735	39·75	1·658	23·3	25·7	49	1·1	4,203	4,164	1·01
1·863	42·76	1·782	27·0	29·8	57	1·1	4,516	4,471	1·01
1·980	45·66	1·900	30·3	34·0	64	1·1	4,775	4,752	1·00
2·105	48·37	2·018	34·5	38·1	73	1·2	5,089	5,052	1·00
2·195	50·64	2·110	37·2	41·8	79	1·4	5,316	5,268	1·01
2·300	53·36	2·221	41·0	46·5	88	1·5	5,596	5,520	1·01
2·431	56·14	2·340	45·7	51·5	97	1·6	5,895	5,834	1·01
2·510	57·96	2·415	48·8	54·8	104	1·7	6,061	6,024	1·00
2·592	60·00	2·500	50·4	58·8	109	1·8	6,266	6,221	1·00
2·668	61·58	2·566	55·0	62·0	117	1·9	6,420	6,403	1·00

TABLE XXIII.—*Thomson-Houston Transformer.*

No. 46,740. Power, 4,500 watts. Secondary volts, 50 and 100.
Frequency used, 82·1 periods per second.
Average final temperature of transformer, 102° F.
Volts on primary circuit (v_1) = 2,400 (kept constant).
Primary circuit resistance = 19·68 ohms at 102° F.
Secondary circuit resistance = 0·019 ohm at 102° F.

Secondary circuit.			Primary circuit.				Total power taken up in transformer.		Efficiency, $\frac{w_2}{w_1}$, in per cents.
					Watts.				
Volts.	Amperes.	Watts w_2.	Volts.	Amperes.	By dynamometer wattmeter w_1.	By Swinburne wattmeter.	By dynamometer wattmeter, $w_1 - w_2$.	By Swinburne wattmeter.	
99·8	0	0	2,400	0·083	116	82	116	82	0
99·8	0·98	98	„	0·119	216	185	118	87	45·4
99·8	1·96	196	„	0·150	320	282	124	86	61·2
99·8	2·90	289	„	0·186	403	380	114	91	71·7
99·7	4·73	472	„	0·250	597	562	125	90	79·1
99·6	6·93	690	„	0·340	818	779	128	89	84·4
99·4	8·89	884	„	0·420	1,005	974	121	90	88 0
99·2	10·95	1,087	„	0·500	1,206	1,183	119	96	90·1
99·0	12·80	1,275	„	0·583	1,410	1,383	135	108	90·5
98·7	15·10	1,490	„	0·671	1,623	1,611	133	121	91·8
98·5	18·00	1,773	„	0·800	1,905	—	132	—	93·0
98·5	20·45	2,014	„	0·900	2,160	—	146	—	93·2
98·3	23·26	2,287	„	1·016	2,447	—	160	—	93·5
98·3	25·50	2,507	„	1·112	2,668	—	161	—	94·0
98·1	27·06	2,655	„	1·173	2,820	—	165	—	94·2
97·9	29·87	2,925	„	1·286	3,090	—	165	—	94·7
97·7	32·50	3,175	„	1·394	3,376	—	201	—	94·2
97·5	35·33	3,445	„	1·506	3,630	—	185	—	94·9
97·3	38·00	3,698	„	1·620	3,921	—	223	—	94·3
97·1	39·85	3,870	„	1·698	4,070	—	200	—	95·1
96·8	41·62	4,035	„	1·773	4,242	—	207	—	95·2
96·7	43·41	4,198	„	1·860	4,418	—	220	—	95·0
96·6	45·08	4,355	„	1·928	4,620	—	265	—	94·3
96·5	46·00	4,439	„	1·960	4,695	—	256	—	94·5
99·8	0	0	„	0	98	84	98	84	0

loss. The maximum total copper loss (c^2 R loss) is 117 watts, and the maximum total loss at full load is 311 watts. The maximum efficiency is close to 96 per cent., and the efficiency at $\frac{1}{10}$th of full load is 80 per cent. These figures are, perhaps, not quite comparable with those of the 20 to 1 6,000-watt transformer worked at 100 ~,

but they are, at any rate, not very different from the values of the similar quantities given by the manufacturers for this last transformer.

We shall deal more at length presently with the important question of the constancy of the iron losses at all loads, which the observations on this transformer bring out most clearly.

TABLE XXIV.—*Thomson-Houston Transformer.*

Primary volts 2,400 (kept constant).
Secondary volts at no load = 99·8.

Primary current, I_1.	Secondary current, I_2.	$\frac{I_2}{24}$.	Copper losses in watts.			Total secondary drop in volts.	Primary watts.		Power-factor, $\frac{w_1}{W_1}$.
			Primary, $I_1^2 \times 19{\cdot}66$.	Secondary, $I_2^2 \times 0{\cdot}019$.	Total.		Real, w_1.	Apparent W_1.	
0·083	0	0	0	0	0	0	116	199	0·58
0·119	0·98	0·041	0·2	0	0	0	216	285	0·76
0·150	1·96	0·081	0·4	0	0	0	320	360	0·89
0·186	2·90	0·120	0·6	0·2	1	0	403	447	0·90
0·250	4·73	0·197	1·3	0·4	2	0·1	597	600	1·00
0·340	6·93	0·288	2·3	0·9	3	0·2	818	816	1·00
0·420	8·89	0·370	3·5	1·5	5	0·4	1,005	1,006	1·00
0·500	10 95	0·456	5·2	2·2	7	0·6	1,206	1,199	1 00
0·583	12·88	0·536	7·0	3·1	10	0·8	1,410	1,400	1·00
0·671	15·10	0·629	9·3	4·3	14	1·1	1,623	1,608	1·01
0·800	18·00	0·750	12·8	6·1	19	1·3	1,905	1,920	0·99
0·900	20·45	0·852	16·3	7·9	24	1·3	2,160	2,160	1·00
1·016	23·36	0·970	20·1	10·2	30	1·5	2,447	2,438	1·00
1·112	25·50	1·061	23·5	12 3	36	1·5	2,667	2,669	1·00
1·173	27·06	1·129	26·0	13·8	40	1·7	2,820	2,815	1·00
1·286	29·87	1·245	31·0	16·8	48	1·9	3,090	3,086	1·00
1·394	32·50	1·352	36·7	20·0	57	2·1	3,376	3,345	1·01
1·506	35·33	1·471	43·1	23·6	67	2·3	3,630	3,614	1·00
1·620	38·00	1·582	51·7	27·0	79	2·5	3,921	3,888	1·01
1·698	39·85	1·661	57·0	30·0	87	2·7	4,070	4,075	1·00
1·773	41·62	1·735	62·0	32·7	95	3·0	4,242	4,255	1·00
1·860	43·41	1·809	68·1	35·7	104	3·1	4,418	4;464	0·99
1·928	45·08	1·880	73·7	38·5	112	3·2	4,620	4,627	1·00
1·960	46·00	1·916	76·0	40·0	116	3·3	4,695	4,704	1·00

TABLE XXV.—*Kapp Transformer*

No. 570. Power, 4,000 watts. Secondary volts, 100.
Frequency used, 82·1 periods per second.
Volts on primary circuit (v_1) = 2,400 (kept constant).
Primary circuit resistance = 11·38 ohms.
Secondary circuit resistance = 0·024 ohms.

Secondary circuit.			Primary circuit.				Total power taken up in transformer.		Efficiency, $\frac{w_2}{w_1}$, in per cents.
					Watts.				
Volts.	Amperes.	Watts, w_2.	Volts.	Amperes.	By dynamometer wattmeter, w_1.	By Swinburne wattmeter.	By dynamometer wattmeter, $w_1 - w_2$.	By Swinburne wattmeter.	
99·0	0	0	2,400	0·145	152	112	152	112	0
99·0	1·00	99	„	0·160	265	212	166	113	37·4
98·9	1·95	193	„	0·200	338	301	145	108	57·1
98·9	2·89	286	„	0·229	445	393	159	107	64·3
98·8	3·98	393	„	0·270	548	494	155	101	71·7
98·8	4·87	481	„	0·304	640	588	159	107	75·2
98·8	7·17	708	„	0·374	868	801	160	93	81·6
98·8	8·85	875	„	0·467	1,029	982	154	107	85·0
98·0	10·81	1,060	„	0·519	1,225	1,176	165	116	86 5
98·7	12·73	1,257	„	0·618	1,426	1,387	169	130	88·1
98·6	14·63	1,443	„	0·675	1,609	1,550	166	107	89·7
98·3	16·49	1,621	„	0·743	1,800	—	179	—	90·1
98·2	18 52	1,819	„	0·831	1,988	—	169	—	91·5
98·1	20·42	2,003	„	0·908	2,182	—	179	—	91·8
98·0	22·25	2,180	„	0·981	2,358	—	178	—	92·5
98·0	24·10	2,362	„	1·052	2,538	—	176	—	93·2
97·9	25·95	2,541	„	1·136	2,745	—	204	—	92·6
97·8	27·86	2,725	„	1·212	2,894	—	169	—	94·3
97·7	29·80	2,912	„	1·288	3,100	—	188	—	94·0
97·7	31·62	3,090	„	1·360	3,289	—	199	—	94·0
97·5	33·41	3,258	„	1·442	3,481	—	223	—	93·5
97·4	35·27	3,436	„	1·520	3,658	—	222	—	93 9
97·3	37 09	3,609	„	1·590	3,821	—	212	—	94·5
97·2	39·14	3,805	„	1·680	4,035	—	230	—	94·4
97·1	40·89	3,971	„	1·750	4,207	—	236	—	94·4

Thomson-Houston 4,500-*watt Transformer.* (Tables XXIII. and XXIV.)

There is nothing which here specially calls for remark. The transformer is a very good example of a high efficiency closed iron circuit transformer of small size. At $\frac{1}{10}$th of full load the efficiency is 79·1 per cent. The open-circuit loss is only 1·6 per cent. of the total full secondary output.

Kapp 4,000-*watt Transformer.* (Tables XXV. and XXVI.)

This is a very interesting transformer, having an exceedingly good regulation for such a small size. Its total secondary drop is under 2 per cent. of its secondary voltage at no load, and its open-circuit loss is 2·8 per cent. of full output. It is curious in the rather slow rise of its power factor as the secondary load is increased. More about this will be said presently. The good regulation of the transformer and small "leakage drop" are no doubt due to the effective "sandwiching" of the primary and secondary coils.

TABLE XXVI.—*Kapp Transformer.*

Primary volts, 2,400 (kept constant).
Secondary volts at no load = 99·0.

Primary current, I_1.	Secondary current, I_2.	$\frac{I_2}{24}$.	Copper losses in watts. Primary, $I_1^2 \times 11{\cdot}88$.	Copper losses in watts. Secondary, $I_2^2 \times 0{\cdot}024$.	Copper losses in watts. Total.	Total secondary drop in volts.	Primary watts. Real, w_1.	Primary watts. Apparent, w_1'.	Power-factor, $\frac{w_1}{w_1'}$.
0·145	0	0	0	0	0	0	152	348	0·61
0·160	1·00	0·042	0·2	0	0	0	265	384	0·66
0·200	1·95	0·081	0·3	0	0	0·1	338	480	0·70
0·229	2·89	0·120	0·5	0·2	1	0·1	445	549	0·81
0·304	4·87	0·203	1·0	0·6	2	0·2	548	648	0·85
0·374	7·17	0·299	1·6	1·3	3	0·2	868	897	0·97
0·467	8·85	0·369	2·5	1·9	4	0·2	1,029	1,121	0·92
0·519	10·81	0·450	3·1	2·8	6	1·0	1,225	1,245	0·98
0·618	12·73	0·531	4·3	3·9	8	0·3	1,426	1,483	0·96
0·675	14·63	0·610	5·2	5·1	10	0·4	1,609	1,620	0·99
0·743	16·49	0·687	6·6	6·5	13	0·7	1,800	1,783	1·01
0·831	18·52	0·771	7·9	8·2	16	0·8	1,988	1,994	1·00
0·908	20·42	0·852	9·4	10·0	19	0·9	2,182	2,179	1·00
0·981	22·25	0·927	11·0	11·9	23	1·0	2,358	2,354	1·00
1·052	24·10	1·001	12·6	13·9	27	1·0	2,538	2,525	1·00
1·136	25·95	1·081	14·6	16·3	31	1·1	2,745	2,726	1·01
1·212	27·86	1·161	16·7	18·6	35	1·2	2,894	2,909	0·99
1·288	29·80	1·241	19·0	21·3	40	1·3	3,100	3,091	1·00
1·360	31·62	1·320	21·0	24·0	45	1·3	3,289	3,264	1·01
1·442	33·41	1·392	23·6	26·7	50	1·5	3,481	3,461	1·00
1·520	35·27	1·469	26·3	30·8	57	1·6	3,658	3,648	1·00
1·590	37·09	1·547	28·6	33·1	62	1·7	3,821	3,816	1·00
1·680	39·14	1·631	32·0	36·8	69	1·8	4,035	4,032	1·00
1·750	40·89	1·703	34·5	42·0	77	1·9	4,207	4,200	1·00

TABLE XXVII.—*Swinburne "Hedgehog" Transformer.*

No. 342. Power, 3,000 watts. Volts, 100.
Frequency used, 81·1 periods per second.
Average final temperature of transformer, 145° F.
Volts on primary circuit (v_1) = 2,400 (kept constant).
Primary circuit resistance = 24·00 ohms at 145° F.
Secondary circuit resistance = 0·051 ohm at 145° F.

Secondary circuit. Volts.	Amperes.	Watts w_2.	Primary circuit. Volts.	Amperes.	Watts. By dynamometer wattmeter, w_1.	Watts. By Swinburne wattmeter.	Total power taken up in transformer. By dynamometer wattmeter, $w_1 - w_2$.	By Swinburne wattmeter.	Efficiency, $\frac{w_2}{w_1}$, in per cents.
101·8	0	0	2,400	0·756	121	55	121	55	0
101·7	1·00	102	„	0·761	213	157	111	55	47·9
101·5	2·97	301	„	0·786	414	357	113	56	72·7
101·3	4·84	490	„	0·811	608	546	118	56	80·6
101·3	6·00	607	„	0·829	730	664	123	57	83·1
101·2	8·00	810	„	0·862	943	869	133	59	85·9
101·0	10·20	1,030	„	0·915	1,161	1,092	131	62	88·6
100·9	12·00	1,211	„	0·960	1,361	1,275	150	64	89·0
100·6	14·00	1,408	„	1·013	1,551	1,477	143	69	90·8
100·3	15·87	1,592	„	1·066	1,750	—	158	—	91·1
100·0	17·89	1,789	„	1·133	1,951	—	162	—	91·7
100·0	19·80	1,980	„	1·197	2,129	—	149	—	93·0
99·9	21·82	2,180	„	1·260	2,344	—	164	—	93·0
99·7	23·66	2,359	„	1·321	2,525	—	166	—	93·3
99·5	25·46	2,534	„	1·397	2,732	—	198	—	92·8
99·3	26·46	2,628	„	1·430	2,823	—	195	—	93·2
99·1	27·42	2,718	„	1·465	2,914	—	196	—	93·4
99·0	28·28	2,800	„	1·500	2,988	—	188	—	93·7
98·9	29·26	2,896	„	1·532	3,103	—	207	—	93·3
99·0	30·20	2,990	„	1·566	3,185	—	195	—	94·0
101·9	0	0	„	0	121	55	121	55	0

Swinburne 3,000-*watt "Hedgehog" Transformer.* (Tables XXVII. XXVIII. and XXIX.)

Lastly, but by no means least, there are several remarks to make about the "Hedgehog" transformer of Mr. Swinburne. As a problem in transformer testing the open-circuit transformer of his is a hard nut to crack. From first to last we have made many hundreds of observations on it. The Tables XXVII., XXVIII., and XXIX. give the results of the two best sets of observations with the dynamometer wattmeter on this transformer. The mean of a number of observations with the dynamometer wattmeter on the power taken up at no load by this transformer gave a value very close to 114 watts. We have already seen that the mean of the three-volt-meter and three-ammeter methods indicated probable values of the power loss close to this number. The dynamometer observations gave values of 114, 108, 108, 114, 114, 121, 121, in seven series of observations at slightly different frequencies. Hence the mean of all means of over 62 observations by three different methods gives the value of 112 watts for the power absorbed at no load in this 3,000-watt "Hedgehog" transformer.

The core of this transformer is composed of soft iron wire 18 inches in length, and each 0·0225 of an inch in diameter. The total volume

TABLE XXVIII.—*Swinburne "Hedgehog" Transformer.*

No. 342. Power, 3,000 watts. Volts, 100.
Frequency used, 82·3 periods per second.
Average final temperature of transformer, 145° F.
Volts on primary circuit (v_1) = 2,400 (kept constant).
Primary circuit resistance = 24·00 ohms at 145° F.
Secondary circuit resistance = 0·051 ohm at 145° F.

Secondary circuit. Volts.	Amperes.	Watts w_2.	Primary circuit. Volts.	Amperes.	Watts. By dynamometer wattmeter, w_1.	Watts. By Swinburne wattmeter.	Total power taken up in transformer. By dynamometer wattmeter, $w_1 - w_2$.	By Swinburne wattmeter.	Efficiency, $\frac{w_2}{w_1}$, in per cents.
101·9	0	0	2,400	0·756	121	55	121	55	0
101·8	1·02	104	„	0·761	228	159	124	55	45·6
101·7	2·98	303	„	0·786	420	359	117	56	72·1
101·5	4·84	491	„	0·811	621	547	130	56	79·1
101·3	6·00	608	„	0·829	730	665	122	57	83·3
101·1	8·00	809	„	0·862	943	868	134	59	85·8
100·9	10·00	1,009	„	0·911	1,152	1,070	143	61	87·5
100·7	12·00	1,208	„	0·960	1,353	1,272	145	64	89·3
100·6	14·00	1,408	„	1·013	1,538	1,477	130	69	91·6
100·4	15·88	1,594	„	1·066	1,746	—	152	—	91·4
100·2	17·89	1,792	„	1·133	1,932	—	140	—	92·8
100·0	19·80	1,980	„	1·197	2,129	—	149	—	93·0
99·8	21·63	2,159	„	1·260	2,320	—	161	—	93·0
99·5	23·58	2,341	„	1·321	2,510	—	169	—	93·4
99·2	25·46	2,526	„	1·395	2,706	—	180	—	93·3
99·0	26·38	2,612	„	1·426	2,829	—	217	—	92·4
98·9	27·28	2,698	„	1·460	2,890	—	192	—	93·3
98·9	28·21	2,790	„	1·498	2,993	—	203	—	93·2
98·7	29·19	2,881	„	1·529	3,042	—	161	—	94·7
98·6	30·33	2,991	„	1·567	3,163	—	172	—	94·5
101·9	0	0	„	0	121	55	121	55	0

TABLE XXIX.—*Swinburne "Hedgehog" Transformer*

Primary volts, 2,400 (kept constant).
Secondary volts at no load = 102·00.

Primary current, I_1.	Secondary current, I_2.	$\frac{I_2}{24}$.	Copper losses in watts. Primary, $I_1^2 \times 24{\cdot}00$.	Copper losses in watts. Secondary, $I_2^2 \times 0{\cdot}061$.	Copper losses in watts. Total.	Total secondary drop in volts.	Primary watts. Real, w_1.	Primary watts. Apparent, w_1'.	Power-factor, $\frac{w_1}{w_1'}$.
0·756	0	0	13·7	0	14	0	121	1,816	0·07
0·761	1·02	0·042	14·0	0·1	14	0·1	228	1,829	0·13
0·786	2·98	0·124	14·9	0·5	15	0·2	420	1,886	0·22
0·811	4·84	0·202	15·8	1·2	17	0·4	621	1,948	0·32
0·829	6·00	0·250	16·5	1·8	18	0·6	730	1,988	0·37
0·862	8·00	0·333	17·8	3·3	21	0·8	943	2,067	0·46
0·911	10·00	0·417	19·9	5·1	25	1·0	1,152	2,188	0·53
0·960	12·00	0·500	22·6	7·3	30	1·2	1,353	2,301	0·59
1·013	14·00	0·584	24·7	10·0	35	1·3	1,538	2,432	0·63
1·066	15·88	0·663	27·2	12·9	40	1·5	1,746	2,559	0·68
1·133	17·89	0·746	30·9	16·3	47	1·7	1,932	2,720	0·71
1·197	19·80	0·825	34·5	20·0	55	1·9	2,129	2,873	0·74
1·260	21·63	0·902	38·2	24·0	62	2·1	2,320	3,022	0·77
1·321	23·58	0·983	42·0	28·3	70	2·4	2,510	3,172	0·79
1·395	25·46	1·060	46·6	33·1	80	2·7	2,706	3,350	0·81
1·426	26·38	1·098	48·9	35·4	84	2·9	2,829	3,422	0·83
1·460	27·28	1·136	51·2	38·0	89	3·0	2,890	3,501	0·83
1·498	28·21	1·175	54·0	40·8	95	3·0	2,993	3,596	0·83
1·529	29·19	1·215	56·1	43·5	100	3·2	3,042	3,666	0·83
1·567	30·33	1·262	59·0	46·9	106	3·3	3,163	3,761	0·84

of iron wire is about 856 cubic centimetres, and weighs 5,982 grammes. The induction in the centre of the core is about 10,000 C.G.S. units. It is clear that with such subdivision of the iron true eddy-current loss in the iron must be small, and my estimate of it is that it does not amount to more than 10 or 15 watts at the frequency used. Also, the true hysteresis loss cannot probably be much greater than 20 to 30 watts. In general one watt per 30 cubic centimetres of core is about the value of the true total core loss in most usual small-sized transformers. How comes it to pass, then, that all the measurements above described point to a loss of about 112 watts at no load? The answer to this question is, I take it, that there may be considerable eddy-current loss in the copper of the secondary circuit. In this transformer the secondary circuit is first wound on the core, and then the primary circuit over it. If we consider for a moment, we shall see that the lines of induction passing up the core return back through the space outside the core, and in so doing they must cut through the copper of the circuits. Hence, at each reversal of induction, unless the copper circuits are exceedingly well stranded, there are eddy-currents set up in the copper mass; and this takes place equally well at full and at no secondary load. The only way to prevent this waste is to make the secondary circuit of stranded wire, each slightly insulated and very small. It is perfectly clear that this loss must take place to some extent, and that it is a special defect of the open magnetic circuit transformer. We may, from one point of view, regard the function of the iron core of a transformer to be the preservation of the lines of induction in the proper place, and making them thread through the aperture of the secondary circuit without intersecting or cutting through the mass of the copper in that circuit.

NEW PATENTS—1892.

22,085. "A varying price electric supply meter." J. PERRY. Dated December 2nd.

22,087. "Electrical variable resistance apparatus." J. A. COLQUHOUN. Dated December 2nd.

22,129. "An improvement in electric switches for currents of high potential." C. J. WHARTON. Dated December 3rd.

22,131. "An insulating material for covering electric and telephone wires, bicycle tyres, and carriage wheels." F. W. W. GOODSALL and H. E. WRIGHT. Dated December 3rd.

22,164. "Improvements in or relating to electrical switches for high tension currents." G. H. NISBETT. Dated December 3rd.

22,187. "Improvements in lightning arresters." R. BELFIELD. (Communicated by the Westinghouse Electric and Manufacturing Company, United States.) Dated December 3rd.

22,261. "Improvements in electric arc lamps." A. F. HILLS. Dated December 5th.

22,271. "Improvements in and connected with carbons for electric arc lamps." C. W. HAZELTINE. Dated December 5th. (Date applied for under Patents Act, 1883, Section 103, May 6th, 1892, being date of application in the United States.)

22,274. "A new or improved shade or screen for electric and other lights." E. W. STREETER. Dated December 5th.

22,285. "An improvement in microphone transmitters." G. L. ANDERS and W. KOTTGEN. Dated December 6th.

TABLE XXX.—*Efficiencies of Transformers calculated from curves of Total Losses. From observations by Dynamometer Wattmeter.*

SIZE AND DESCRIPTION OF TRANSFORMER.	FRACTIONS OF FULL SECONDARY LOAD.												
	0	0·025	0·05	0·1	0·2	0·3	0·4	0·5	0·6	0·7	0·8	0·9	1·0
	PERCENTAGE EFFICIENCIES.												
6,500-watt Westinghouse	0	61·8	75·9	85·7	91·9	94·0	95·1	96·0	96·3	96·6	96·8	96·9	96·9
3,000-watt Swinburne	0	39·3	56·2	71·7	82·9	87·6	89·8	91·2	92·2	92·8	93·2	93·4	93·5
4,500-watt Thomson-Houston	0	49·1	65·4	78·8	87·8	91·1	92·9	93·8	94·2	94·6	95·0	95·0	94·7
20-H.P. 1892 pattern Ferranti	0	62·0	76·6	86·5	92·6	95·0	95·6	96·1	96·5	96·8	96·8	96·6	96·6
15-H.P. " " "	0	65·5	79·0	88·1	93·4	95·0	95·7	96·0	96·2	96·3	96·1	95·8	95·5
15-H.P. " " " (re-wound)	0	55·0	70·8	83·0	90·5	93·1	94·5	95·1	95·4	95·5	95·4	95·2	94·7
6,000-watt Mordey	0	52·1	67·6	80·1	88·5	91·1	92·7	93·7	94·2	94·7	94·9	95·1	95·4
4,000-watt Kapp	0	39·5	56·5	72·3	83·8	88·0	90·4	91·9	92·6	93·3	93·8	94·0	94·2
5-H.P. 1885 pattern Ferranti (re-wound)	0	28·8	44·5	61·4	75·6	81·9	85·5	87·7	89·0	89·8	90·2	90·5	90·8
5-H.P. " " "	0	14·6	25·3	40·3	57·2	66·5	72·5	76·4	79·1	81·5	83·1	84·5	85·5

I proposed to Mr. Swinburne to obtain convincing proof of the correctness or incorrectness of this view by winding an exactly similar transformer with a dummy secondary circuit of string or rope. If such a transformer with only primary circuit were tested, I believe it would show a far smaller power-absorption than the actual transformer does. His firm have not yet been able to try this experiment, but it would be most interesting and satisfactory to have it tried. In any case, it seems to me clear that in the "Hedgehog" tested by us there is probably a large eddy-current loss in the copper, and that this accounts for the abnormally large loss on open circuit, which cannot well be accounted for in the iron core alone, unless phenomenally bad iron has been employed. I venture to suggest, therefore, that Mr. Swinburne should direct his attention to getting rid of this copper eddy loss, because, as it stands, this 3,000-watt "Hedgehog" must be kept down in efficiency from this cause. If we compare the efficiency curve of this transformer with that of a closed magnetic circuit transformer of nearest size, we see that the open magnetic circuit so far gives no advantage in efficiency at the low loads. This "Hedgehog" has an efficiency of about 73 per cent. at one-tenth load, and 94 or 95 per cent. at full load. A transformer with a closed magnetic circuit and of not much greater output can be built to adjust as well, or better, than this, as can be seen by an inspection of the efficiency curves of the Kapp or Thomson-Houston transformers. If, however, the eddy-current loss in the copper can be entirely destroyed, and the large magnetising current provided by non-wasteful condensers, the open-circuit transformers may perhaps be made more efficient at low loads than closed-circuit transformers of equal output. To attempt to predetermine the efficiency of this type of transformer as now made by calculations carried out on the assumption that the only internal loss is the eddy and hysteresis loss in the iron, leads to considerable overstatement of the efficiency.

If subsequent experiments should confirm this view that at present there is considerable avoidable loss in the copper circuits of the "Hedgehog," it is clear we are not yet at the end of our inquiries; and until it has been freed from this defect, it does not show inherent superiority over its closed-circuit rival. When it has arrived at the ideal condition, and enjoys the constant presence of a condenser imparting to it its necessary magnetising current, which in the 3,000-watt "Hedgehog" is nearly 50 per cent. of the full-load primary current, we shall be in a position to give it a final verdict, and say if the result could not be just as well obtained by adding the necessary small amount of iron to complete the magnetic circuit.

(To be continued.)

22,308. "Improvements in incandescent electric lamps." E. W. APPLEGATE. Dated December 6th. (*Complete.*)

22,333. "Improvements in ammeters and voltmeters." E. HARTMANN. Dated December 6th.

22,344. "Improvements in galvanic batteries." W. WALKER and F. R. WILKINS. Dated December 6th.

22,346. "Improvements in telephonic switching apparatus." J. D. MILLER. Dated December 6th.

22,355. "Improvements in the manufacture of electro-printing surfaces.' A. GRAY. Dated December 6th.

22,375. "Improvements in the method of welding or working metals electrically." W. P. THOMPSON. (Communicated by C. L. Coffin, United States.) Dated December 6th. (*Complete.*)

22,422. "An improved automatic electrical call apparatus principally for use in telephone circuits." N. KHEM. Dated December 7th.

22,473. "Improvements in dynamo-electric machines." C. E. L. BROWN. Dated December 7th.

22,534. "Improvements in musical instruments operated by electricity." P. E. SINGER. Dated December 8th.

22,589. "Improvements in electric switches." W. M. MORDEY. Dated December 8th.

22,615. "Improvements in electric current meters." M. B. FIELD. Dated December 9th.

22,657. "A new or improved electric accumulator." J. G. LORRAIN. (Communicated by M. Dumont, France.) Dated December 9th.

22,699. "Improvements in musical instruments actuated by electricity." P. E. SINGER. Dated December 10th.

22,719. "Improvements in street boxes used in the underground distribution of electricity." W. GEIPEL. Dated December 10th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1891.

The Price of all Specifications (old and new) is now 8d. each.

7,372. "Improvements in means or apparatus for actuating, hammering, caulking, rock-boring, or like percussive machinery by the aid of electricity." R. BOLTON and W. C. MOUNTAIN. Dated April

29th. The inventors obtain reciprocation by the tractive drawing power of electro-magnets or solenoids acting upon a soft iron ring, bar, or part attached to the reciprocating parts by an elastic or flexible connection, whereby the shock of the blow or of the over-running of the reciprocating parts is taken from the electrical working parts, and the resulting stroke is variable in extent, and the blow thereof is of an elastic or springy nature. 4 claims.

7,430. "An improved pulley for use in driving dynamo-electric machines." A. W. HEAVISIDE, R. C. JACKSON, and J. RICHARDSON. Dated April 29th. The inventors provide the pulley proper with lugs within it, and also with faced surfaces in its inner periphery. The lugs have casings containing springs attached, the opposite ends being linked to lugs of plates, or rims of internal pulley-like frames, with faced surfaces to bear and slide against the faced surfaces of the pulley proper under the action of the springs. This internal frame has its boss affixed on the dynamo shaft, which becomes driven from the pulley proper through the springs which connect them. 1 claim.

7,433. "A leakage detector or insulation tester to be employed in the testing of electric lighting conductors and other leads." Sir D. L. SALOMONS, Bart. Dated April 29th. The instrument consists of coils of insulated wire of suitable resistance. Within the coils a magnetic needle is mounted upon an axis. There is a pointer upon the axis which, when the needle is deflected, moves over the face of a dial. The scale is graduated to give the resistance of a leak in ohms; the divisions are numbered from 1 to 100, and each unit signifies 10,000 ohms. A key is provided which rocks on an axis, and beneath the key are two contact studs, one connected with the positive lead, and the other with the negative lead; the key is placed in communication with one or the other of the leads, according as one or other of its ends is pressed down. The key is also connected with one end of the wire forming the coils, and the other end is connected to earth through a safety fuse wire. When the key is put down in either direction, it earths one of the leads through the coils, and the current passing (which is dependent on the insulation of the other lead), deflects the needle, and the resistance of the leak or value of insulation resistance is read off. The key then has only to be reversed, and the leakage of the other lead is similarly indicated, and may be read off from the instrument. 4 claims.

7,518. "A new or improved combined transmitting and receiving sounder telegraph instrument." T. A. BULLOCK and A. C. BROWN. Dated April 30th. Claims:—1. In a telegraphic receiving instrument of the "sounder" type an armature or rocking diaphragm consisting of a hollow sound box or shallow closed chamber, substantially as set forth. 2. In conjunction with the armature or rocking diaphragm referred to in the preceding claim, the combination and arrangement of parts constituting the new or improved combined transmitting and receiving sounder telegraph instrument, substantially as set forth and illustrated.

7,531. "Improvements in tools for electric linesmen." A. CUTHBERT. Dated May 1st. Relates to a tool, or pair of tools, for bearing and cleaning electrically-insulated wire as a preparation for making electrical joints and connection, or other purposes. 3 claims.

7,697. "Improvements in electrical accumulators or storage batteries." C. P. ELIESON. Dated May 4th. Consists in providing electrodes, each of which is built up of a series of corrugated envelopes of cylindrical or other desirable shape composed of thin lead or other suitable metal and preferably perforated. These envelopes are placed one within the other, and the corrugations are so arranged that those of one cylinder cross, or are at an angle to those of the adjacent cylinders. 3 claims.

7,728. "Improvements in lamp-posts or columns for electric arc lighting." J. LEA. Dated May 5th. Claims:—1. The placing of the regulating mechanism in the lower body of the post or support and operating the carbon therefrom. 2. The arrangement or method of protecting the working parts of the regulating mechanism from the damaging influence of the weather. 3. The balanced bar, Y, with pulleys, said bar having an extension with solenoid core attached, and acting in the manner and for the purposes set forth.

8,048. "Improvements in dynamo-electric generators." R. KENNEDY. Dated May 11th. All the coils of insulated wires are fixed and stationary, the only rotary part being a series of laminated iron inductors, mounted on wheels keyed to a spindle free to rotate. There is only one exciting coil on the dynamo-electric machine, but this exciting coil is divided into two equal divisions, connected together in series for the purpose of neutralising inductive effects on the exciting circuit, the inductive effect on the one division being made opposite and equal to that on the other division. 6 claims.

16,958. "Improvements in or relating to metallic junction boxes or cases for conductors or fittings for electric lighting, electric bell circuits, and like purposes, and in the mode of connecting the conductors thereto." H. A. MAVOR, W. A. COULSON, S. MAVOR, and W. B. SAYERS. Dated October 6th. Has for its object to provide improved means of connecting the head or other external part or sheathing of the conductors to the junction boxes or cases, and whereby any risk of damp or moisture seeking or searching back from the junction box or case along the insulating coating of the central conductor in either direction is obviated, whilst at the same time the improved construction greatly facilitates the making of the connection, and the insertion of apparatus within the junction box or case by enabling the work to be performed from above. 4 claims.

19,968. "Improvements in electric motors and dynamos." M. C. BURT. Dated November 17th. Have for their object, first, certain improvements in the framework of such machines, whereby a cheap, rigid, and powerful frame may be obtained; second, certain improvements in the construction of armatures and certain attachments therefor, by means of which the armature, commutator, and coils upon the former may be kept cool and free from dust and filings, in order that the maximum efficiency and safety may be attained; and, third, certain improvements in the outside wiring, whereby a single dynamo may be made to do the work of two or more, and the power of the machine increased to meet the added requirement of the increased work. 4 claims.

CHICAGO EXHIBITION.

A MEMORANDUM has been prepared by the Electrical Committee of the Royal Commission for the Chicago Exhibition, at the request of Prof. Elisha Gray, chairman of the Electrical Congress which is to be held at Chicago next year. The following are subjects on some of which it is proposed that short and suggestive special papers might be read by specially selected members:—Comparison between procedure in different countries. Methods of avoiding electrical interference and risks to person and property. Units of magnetic quantities, and mode of embodying them in concrete standards. The adoption of the name "Henry" for the unit of self and mutual induction. Adoption of the "kilowatt" instead of the "horse-power" as the unit of power. International nomenclature for describing phenomena of alternate currents, and of electro-magnetic waves. National and municipal testing laboratories. Materials for standards of electric resistance. Points of difference of the electrical vocabulary used in different countries. The direct conversion of the energy of fuel into electric energy. Comparison of the various methods employed for the electric transmission of power. The cost of insulation in relation to high pressure for the electric transmission of power. Comparison of the economics of the various systems of electric distribution. Alternate current motors. The behaviour of transformers when supplying power to alternate current motors. The construction of condensers for alternate current purposes. The measurement of power in polyphase currents. Direct coupled and non-direct coupled dynamos. The use of equalising dynamos in a three and a five-wire system. The use of accumulators in central stations. The proportions between output of dynamos and the weight of copper and iron employed in their construction. Electric traction. Application of electric power in mining. The adoption of a uniform method of distinguishing positive and negative mains. Electric supply meters—American, British, Continental. Criterion of sensibility of galvanometers. Commercial instruments for measurement of electric quantities. The relation between the voltage of the arc and the quality and composition of the carbons. The ageing of glow lamps. The electric working of metals. The use of electric and magnetic tests for ascertaining the mechanical properties of metals and alloys. The best material and mode of erection of lightning conductors in the light of recent researches in electric discharges. The prospecting for iron by magnetic surveys. International telegraphy. Fast speed and long distance telegraphy. The use of batteries or other generators for telegraphy. Telegraphic lines, land and sea. Harmonic telegraphy. Writing telegraphs. Long distance telephony. The possibility of providing telephonic communication without wires. Application of electric signalling to the working of railways (alarms, time, &c.), and to naval and military purposes. Magnetic separators. The use of electricity in engraving and in art reproductions.

The committee who have prepared this report are Messrs. W. E. Ayrton, Silvanus P. Thompson, and C. E. Webber, and they suggest that it would be desirable that a selection should be made as soon as possible, by the American organisers of the congress, of the actual subjects that it is proposed to deal with, so that, even before it is decided who will be requested to prepare the papers, and the order in which they will be taken, the delegates of the several nations may be made acquainted with the selected list of subjects. On receipt of that information the British Committee will be prepared, if desired, to suggest the names of probable authors, and, if their suggestions be accepted, to arrange with the authors so that the papers may be ready for the congress. They suggest that a committee for the organisation of the congress shall meet at Chicago immediately before the date decided on for its opening, to arrange, amongst other matters, for the printing of the papers in full, or in abstract if desirable, and for the preparation of the programmes of daily business.

CORRESPONDENCE.

A Strange Incident.

The phenomenon mentioned by "Mystified" in the last issue of the ELECTRICAL REVIEW is easily explained. The momentary brightness of the lamp was due to the recoil current from the magnet shunt.

The momentary recoil current is a result of the rapid demagnetisation of the field-magnets and is, of course, contrary in direction to the impressed E.M.F. of the armature.

In some forms of dynamos the voltage is sufficiently high, under similar circumstances, to burn the lamp filament or give an ugly shock to anyone who happens to connect himself in place of the pilot lamp.

A. H. Gibsons.